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REPUBLIC STEEL QUARRY
ELYRIA, OHIO
FINAL SUPPLEMENTAL REPORT
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REPUBLIC STEEL QUARRY
SUPPLEMENTAL REPORT
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EXECUTIVE SUMMARY

PURPOSE OF INVESTIGATION AND REPORT

The United States Environmental Protection Agency (EPA) has performed a supplemental investigation at the Republic Steel Quarry site in Elyria, Ohio, to evaluate potential limited health risks identified during the Phase I remedial investigation (RI). The supplemental investigation was performed under authority of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and Superfund Amendments and Reauthorization Act (SARA). The primary objective of the supplemental investigation was to provide additional data for quantifying potential limited health risks identified by the Phase I RI. Results from supplemental investigation activities will be used to either support a site deletion petition to remove the site from the National Priorities List (NPL) or to identify public health risks posed by the site that may require remedial measures to be undertaken.

The specific objectives of this supplemental investigation report are to:

- o Provide a summary of additional activities performed at the site following completion of the Phase I RI.
- o Provide additional data on the presence or absence of chemical contamination in surface soils, groundwater, and fish tissue at the site.
- o Revise the exposure and risk assessment for current use and future use conditions at the site to incorporate data collected during supplemental investigation activities into the exposure and risk evaluation.

SITE BACKGROUND

The Republic Steel Quarry site is located east of West River Road and west of the West Branch of the Black River, directly across the river from Franklin School in Elyria, Ohio. The City of Elyria is located southwest of Cleveland in Lorain County in northeastern Ohio.

The site consists of a five acre quarry and the fenced area surrounding the quarry. Water in the quarry has been measured at depths up to 62 ft. The sides of the quarry are nearly vertical and rise to an average of about 20 to 30 ft. above the quarry water surface elevation. Although the site is fenced, it is still accessible through holes in the fence. Water from the quarry discharges directly to the West Branch of the Black River. Water in the quarry is in direct contact with the Berea Sandstone formation which is a water supply aquifer in the area.

The Republic Steel Quarry site was operated as a sandstone quarry during an unknown period of time prior to 1950. Stone cut from the quarry was the Berea Sandstone, which was used as a building material.

From 1950 to 1972 Republic Steel Corporation discharged waste pickle liquor to the five acre quarry. The approximate volume of waste disposed into the quarry was estimated to be 200,000 gallons/year by Republic Steel personnel.

The quarry water was sampled by Republic Steel Corporation in March and April of 1976. Stratified water quality was detected with the deeper waters having higher iron concentration and lower pH than shallower water. In 1977, the quarry was sold to the City of Elyria.

In 1981, Republic Steel Corporation notified EPA of the disposal activity under Section 103(C) of the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA). In response to Republic Steel's notification, Ecology and Environment, Inc. (E & E) performed a site investigation for EPA as its Field Investigation Team (FIT) contractor in late 1983 and installed three monitoring wells. Water samples were collected from the quarry and the monitoring wells. The site was evaluated relative to the Hazard Ranking System in 1984. On October 15, 1984, EPA proposed that Republic Steel Quarry be included in Group II of the National Priorities List (NPL).

IT Corporation (IT), at the request of LTV Steel, conducted an investigation of the site in November, 1984. This investigation concluded that EPA's Hazard Ranking System score should be recomputed based on evidence obtained in IT's investigation. A remedial investigation was conducted by ICF Technology to confirm or refute the presence of site related environmental and public health hazards.

SUMMARY OF PHASE I RI ACTIVITIES

The field activities of the RI were performed from June through August, 1987. The major activities utilized to collect data during the RI included:

- o Profiling of quarry water quality and depth;
- o Performance of a magnetometer survey to identify metal objects on the quarry bottom;
- o Reconnaissance of quarry surface geology;
- o Chemical characterization of surface water from the quarry and the Black River;
- o Chemical characterization of sediment from the quarry and the Black River;
- o Chemical characterization of surface soils adjacent to the quarry;
- o Installation of eight monitoring wells and sampling of groundwater;
- o Property boundary research.

Samples of surface water, sediments, surface soils and groundwater were collected and analyzed to estimate the types and extent of contamination due to the site. The conclusions with respect to the contamination of each media are included in the following items.

Surface Water: Surface water samples were collected from the quarry and Black River adjacent to the site during June 1987. Resampling was performed during March 1988 for semi-volatile organic analyses due to laboratory quality control problems that occurred during the initial analyses. To estimate the extent and nature of contamination, two analyses of the results were performed. Initially, the quarry water samples were compared to upgradient groundwater samples to identify potentially site related chemicals in the quarry. No organic chemicals were identified in the quarry water as being potentially site related. Several inorganic chemicals were identified as being potentially site related. All of these chemicals were detected at elevated concentrations compared to upgradient groundwater, with the greatest concentrations observed near the quarry bottom. The downstream Black River samples were compared to upstream river samples and quarry samples to estimate if the site was affecting river water quality. The results of this comparison indicated that the site was not adversely impacting Black River water quality.

Sediments: Sediment samples from the quarry and the Black River were collected in June 1987 and analyzed for organic and inorganic chemicals. The nature and extent evaluation for sediments was performed in two phases to determine if the quarry sediments were contaminated and to estimate if the quarry had adversely impacted the quality of Black River sediments. Initially, quarry sediments were compared to background soils to identify potentially site related chemicals. This analysis concluded that sediments within the quarry contain elevated levels of volatile and semi-volatile organic chemicals and inorganic chemicals. Volatile organic compounds were detected only in the deep quarry sediment samples (greater than 35 ft.) while semi-volatile organics and inorganics were detected in both deep and shallow samples. Concentrations of the inorganic and semi-volatile contaminants of the sediments obtained from deeper portions of the quarry were greater than those from the shallow sediments. The evaluation indicates that past activities at the site have affected quarry sediment quality.

A comparison of downstream Black River sediments to upstream river and quarry sediments was performed to estimate if the site is adversely impacting Black River sediments. The analysis indicated that no potentially site related organic or inorganic chemicals were detected in the sediments downstream. The site is not affecting sediments in the Black River.

Surface Soils: Surface soil samples were collected in June 1987. Analyses performed on surface soils obtained from areas of the site that are periodically inundated by quarry water or that were exposed to waste discharges in the past detected contaminants above background concentrations. Contaminants detected included volatile and semi-volatile organic chemicals and inorganic chemicals. Past disposal activities appear to have affected the quality of surface soils at the site. Semi-volatile organic chemicals and inorganic chemicals were also detected in a sample of the steel yard soils that are sliding into the quarry.

Groundwater: Eight monitoring wells were installed at or near the Republic Steel Quarry Site. All of these wells were sampled in August 1987 and two wells were resampled and analyzed for volatile organics in March 1988. Methylene chloride and acetone were detected at elevated concentrations in one downgradient monitoring well during August 1987. Resampling during March 1988 did not detect volatile organic contaminants at the downgradient monitoring

well, suggesting that the acetone and methylene chloride found during August 1987 may have been due to laboratory or sampling procedure contamination. In an effort to be conservative during the endangerment assessment, these two volatile organic chemicals were considered present in groundwater at the site. Inorganic chemicals were detected in all downgradient wells adjacent to the site and in the well across the Black River; however, a direct connection to the site cannot be made to the inorganic chemicals in well B-8. Moreover, it is unlikely that contaminants from the quarry are passing beneath the Black River within groundwater since well B-8 is hydraulically upgradient from the site.

PHASE I RI ENDANGERMENT ASSESSMENT SUMMARY

The potential risks to human and environmental health attributed to chemicals present at the Republic Steel Quarry Site were evaluated in the endangerment assessment under a number of exposure scenarios. Potential pathways of exposure to chemicals originating at the site under both current-use and hypothetical future-use conditions were examined.

Under current-use conditions, the only exposure scenario resulting in a greater than 10^{-6} risk is the maximum case for ingestion of fish. This risk is primarily due to carcinogenic PNAs which were conservatively estimated using the sediment/surface water exposure model. Additionally, this maximum exposure scenario results in a total noncarcinogenic hazard index greater than one due primarily to mercury and manganese. This risk is based on modeling using very conservative assumptions. Combined risks to trespassers, assuming the same person would be exposed to soil through direct contact with incidental ingestion, quarry water through swimming, and fish through ingestion were estimated. The combined upper bound excess lifetime cancer risks are 3×10^{-8} to 4×10^{-6} under average and maximum exposure conditions. The combined hazard index is less than one under the average scenario and greater than one under the maximum scenario.

Under future-use conditions the exposure scenarios evaluated that resulted in a greater than 10^{-6} upperbound excess lifetime cancer risk are maximum exposure to future residents through direct contact and incidental ingestion of soil, and average and maximum exposure via ingestion of groundwater. Consequently the combined potential residential risk is 2×10^{-6} to 5×10^{-5} under average and maximum exposure scenarios. It should be noted that the risk from exposure to contaminants in soil is primarily due to exposure to cPNA's, which were detected primarily at one area of the site (the south boat launch) and which are ubiquitous in the environment. The exposure scenario for ingestion of groundwater assumed methylene chloride and acetone were present in groundwater, although the presence of these contaminants was not confirmed during a subsequent groundwater sampling effort. In evaluating the combined noncarcinogenic risk, the hazard index is greater than one under the maximum exposure scenarios. However, none of these noncarcinogenic chemicals in groundwater, have chronic daily intakes that exceed available criteria. In addition, each of the chemicals of potential concern with the highest CDI:RfD ratios have different end points of toxicity. Therefore, impacts from ingestion of noncarcinogenic chemicals are not expected.

FISH SPECIES SURVEY/FISH TISSUE SAMPLING INVESTIGATION

The Phase I RI endangerment assessment (EA) concluded that the only current-use exposure scenario resulting in a greater than 10^{-6} excess lifetime cancer risk was the maximum exposure condition for ingestion of fish from the quarry. This risk was primarily due to carcinogenic PNAs that were conservatively estimated using the sediment/surface water exposure model. Although the Phase I RI EA noted that PNAs are metabolized by fish, to be conservative, the risks posed by fish ingestion were not reduced to account for PNA metabolism.

Following completion of the Phase I RI EA, USEPA and the REM IV team attempted to identify analytical methods for quantifying the level of carcinogenic PNAs in quarry fish tissue. Based on conversations with personnel from the National Fisheries Contaminant Research Center, U. S. Fish and Wildlife Service, and National Oceanic and Atmospheric Administration (NOAA), and a review of published literature, USEPA, Ohio EPA and the REM IV team concluded that detectable levels of PNAs will not be present in fish tissue at the Republic Steel Quarry site because PNAs will be metabolized by the fish. No other organic compounds were determined to pose a significant health risk in the endangerment assessment.

The maximum exposure condition for the current-use scenario also resulted in a total noncarcinogenic hazard index greater than one. The noncarcinogenic hazards were posed primarily by mercury and manganese. Therefore, USEPA, Ohio EPA, and the REM IV team concluded that manganese and mercury concentrations in fish tissue should be evaluated to estimate the noncarcinogenic health hazards posed by fish tissue ingestion.

A fish community survey was performed by ASC and ICF personnel on August 7 through 10, 1989 to provide data on the numbers and types of fish that inhabit the quarry and Black River near the site. The fish community survey provided information on species composition and relative abundance.

Sixteen fish tissue samples and one whole body sample were prepared on August 11, 1989 at the Aquatic Systems Corporation (ASC) laboratory using fish collected from the quarry and the Black River, upstream from the Mussey Avenue dam and downstream from the quarry outfall. The Black River tissue samples served as risk comparison samples in this study, since the 1987 Remedial Investigation indicated that the site was not adversely impacting the water quality or sediments in the Black River. The seventeen fish samples were analyzed for manganese, mercury, and percent lipids.

Elevated concentrations of mercury and manganese were observed in fish tissue samples from the quarry and downstream compared to upstream samples. Mercury and manganese were retained as chemicals of concern and included in the revised endangerment assessment. The concentrations of mercury and manganese present in the fish tissue are significantly below the concentrations predicted from the conservative modeling used for preparing the Phase I RI endangerment assessment.

EPA EMERGENCY RESPONSE SECTION SURFACE SOILS INVESTIGATION

Based on the Phase I RI findings, the Record of Decision (ROD) concluded that approximately 100 cubic yards of contaminated soils should be removed from the

south end of the quarry, due to low concentrations of polynuclear aromatic hydrocarbons (PNAs) detected in soils from the pickle liquor discharge ditch and boat launch areas.

The two potentially responsible parties (PRPs) were sent special notice letters to pay for the removal of the contaminated soils, however, the PRPs did not offer to perform the work. On June 6, 1989, the PRPs were notified that negotiations were terminated and that EPA intended on performing the Remedial Design/Remedial Action (RD/RA) at the site.

Site Assessment Activities

EPA requested that the Technical Assistance Team (TAT) collect verification samples in order to confirm the need for the soil removal and to delineate the extent of the soil contamination. On August 8, 1989 a total of nineteen grab samples were collected, including two duplicate samples and two background samples. The nineteen grab samples were analyzed for base neutral and acid extractable organics (BNAs). Additionally, two composite samples were collected and analyzed for disposal parameters and Extraction Procedure (EP) Toxicity for metals.

The soil samples collected from the site showed the presence of four PNA carcinogenic compounds targeted by the EPA for determining the extent of soil removal. These four target compounds were benzo(b)-fluoranthene, benzo(k)fluoranthene, chrysene, and benzo(a)anthracene. EPA established cleanup criteria for the soil removal specifying that if the sum of the four target compounds exceeded 300 parts per billion (ppb), removal would be required. Soil samples from both the boat launch area and the pickle liquor discharge ditch were observed to exceed the established cleanup criteria.

The analyses for disposal parameters performed on the two composite samples, S-85 and S-86, did not indicate any characteristically hazardous materials and the analyses for EP Toxicity metals indicated concentrations below the maximum acceptable levels.

Soil Removal Activities

On September 9, 1989, an Action Memorandum was submitted to the U.S. EPA Office of Superfund requesting funding for a removal action at the Republic Steel Quarry site. The Record of Decision (ROD) indicated that the removal of an estimated 100 cubic yards of contaminated soils would be required. TAT met with the OSC and the ERCS contractor, MAECORP, on February 14, 1990, to begin the contaminated soil removal.

The RI estimated that bedrock was located 6-12 inches below the surface in the boat launch and pickle liquor discharge ditch areas because of the Berea sandstone outcrops that are adjacent to these areas. The bedrock was at greater depth due to quarrying operations that removed additional sandstone from the south end of the site. The excavated soils were landfilled at EnviroSAFE Services in Oregon, Ohio, approximately 2 hours from the site. Post-excavation sampling of the boat launch and drainage ditch areas was performed by TAT to ensure that the levels of contamination had been reduced to below the cleanup criteria. Results indicated that the composite sample collected from the drainage ditch contained the four targeted compounds in

concentrations exceeding the 300 ppb action level. The results of the boat launch area indicated the removal in this area was successful.

Additional soil sampling was performed on April 27, 1990, to assess the vertical extent of soil contamination in the drainage ditch. TAT expected that a decreasing concentration gradient of PNAs would be seen as sampling progressed further from the surface. The April 27 sampling consisted of a composite from the drainage ditch taken at a depth of one foot. The concentrations of the four targeted compounds were well below the established 300 ppb action level.

On June 13, 1990, TAT met with the OSC and MAECORP to resume excavation and removal of contaminated soils in the drainage ditch. Soil was removed from the ditch to a depth of one foot. A total of approximately 40 cubic yards of soil was removed from the ditch and transported to EnviroSafe Services for landfilling. Post-excavation sampling was performed in the drainage ditch. Analytical results of this sampling indicated that the total concentration of the four targeted compounds was less than the 300 ppb cleanup criterion.

The soil removal successfully reduced soil PNA concentrations in the boat launch and pickle liquor discharge ditch to levels below the established cleanup criterion. Low levels of PNAs and other semi-volatile organic compounds still remained in the pickle liquor discharge ditch, and these compounds were included in the revised endangerment assessment.

GROUNDWATER RESAMPLING INVESTIGATION

During the Phase I RI, two groundwater sampling efforts were conducted. The first groundwater sampling program involved sampling the eight wells and was performed during the week of August 17, 1987. Twelve groundwater samples consisting of eight well samples, a duplicate sample, a bottle blank, a bailer blank, and a sample of the water used by the drillers for coring and packer testing were collected and submitted for laboratory analyses.

A second groundwater sampling program was performed on March 14, 1988, to verify the presence of volatile organic compounds (methylene chloride and acetone) detected at Well B-1 during the first groundwater sampling program. It should be noted that acetone and methylene chloride are common laboratory contaminants. Four samples were collected, including a bottle blank, bailer blank, groundwater sample from monitoring well B-1 and a groundwater sample from well B-3. The second program did not detect acetone or methylene chloride in groundwater samples from the site.

EPA concluded that eliminating the August 1987 volatile organic data from the exposure assessment, based solely on March 1988 resampling data, was not conservative. Therefore, a third groundwater sampling program was conducted on October 5, 1988 to confirm or refute the presence of volatile organic compounds in groundwater downgradient from the site. The third groundwater sampling effort was necessary because the conflicting data on acetone and methylene chloride concentrations have significant impact on future use exposure scenarios involving groundwater ingestion.

The October 1988 sampling effort also did not detect any VOCs in groundwater. Based on the March 1988 and October 1988 groundwater resampling efforts, both

of which failed to detect volatile organic contaminants, groundwater at the Republic Steel Quarry site is estimated to be free of volatile organic contamination. The one downgradient monitoring well sample that detected acetone and methylene chloride during the August 1987 program is believed to have been due to laboratory or sampling procedure contamination. The revised endangerment assessment (EA) therefore eliminated acetone and methylene chloride from the groundwater chemicals of concern. However, previous results of groundwater sampling performed during the Phase I RI indicate that the quarry is contributing to elevated levels of semi-volatile organic and inorganic chemicals in groundwater downgradient from the site. Semi-volatile organic and inorganic chemicals of concern identified in groundwater during the Phase I RI are included within the revised EA.

REVISED ENDANGERMENT ASSESSMENT

The revised endangerment assessment addresses the potential human health and environmental impacts associated with the Republic Steel quarry site under the no-action alternative, that is, in the absence of remedial (corrective) action. The methodologies used in the revised EA are designed to be consistent with guidelines from the Office of Emergency and Remedial Response (Public Health Evaluation Manual 1986) and federal guidelines for risk assessment (EPA 1986).

In the revised endangerment assessment, the potential risks to human health attributed to chemicals present at the Republic Steel Quarry site were evaluated under a number of exposure scenarios. Potential pathways of exposure to chemicals originating at the site under both current-use and hypothetical future-use conditions were examined. Table ES-1 presents a summary of the risks associated with the various scenarios evaluated. Additionally, combined risks are presented for those exposure pathways that could potentially apply to the same receptors.

Under current-use conditions, none of the exposure scenarios result in a greater than 10^{-6} risk. Additionally, the hazard index is less than one for all exposure scenarios evaluated with the exception of the plausible maximum exposure scenario for consumption of fish. The hazard index for the plausible maximum exposure scenario for consumption of fish is equal to one. However, the three chemicals that primarily contribute to the hazard index do not have the same endpoint of toxicity. Additionally, the chemical comprising the largest percentage of the hazard index for consumption of fish is cadmium. It should be noted that cadmium was added as a chemical of concern in this EA, and was detected in only one of twenty samples. Combined risks to trespassers, assuming the same person would be exposed to soil through direct contact and incidental ingestion, quarry water through swimming, and fish through ingestion were estimated. As indicated in Table ES-1 the combined upperbound excess lifetime cancer risks are 1×10^{-8} and 7×10^{-7} under average and maximum exposure conditions, respectively. The combined hazard index is less than one under the average scenario and equal to one under the maximum scenario.

Under future-use conditions the exposure scenarios evaluated that resulted in a greater than 10^{-6} upperbound excess lifetime cancer risk are maximum exposure to future residents through direct contact and incidental ingestion of soil, and average and maximum exposure via ingestion of groundwater.

TABLE ES-1
SUMMARY OF POTENTIAL RISKS ASSOCIATED WITH THE REPUBLIC STEEL QUARRY

Exposure Scenario	Total Cancer Risks		Noncarcinogenic Hazard Index	
	Average	Maximum	Average	Maximum
<u>Current-Use</u> (Trespassers)				
Direct Contact with Soil	2×10^{-9}	1×10^{-7}	<1	<1
Swimming in the Quarry	8×10^{-12}	3×10^{-10}	<1	<1
Consumption of Fish	8×10^{-9}	6×10^{-7}	<1	=1
Combined Risk to Trespassers	1×10^{-8}	7×10^{-7}	<1	=1
<u>Future-Use</u>				
Park Patron - Direct Contact with Soil	5×10^{-9}	4×10^{-7}	<1	<1
Residential Use - Direct Contact with Soil	5×10^{-8}	5×10^{-6}	<1	<1
Residential Use - Ingestion of Groundwater	1×10^{-4}	3×10^{-4}	<1	>1
Combined Residential Risk	1×10^{-4}	3×10^{-4}	<1	>1

Consequently the combined potential residential risk is 1×10^{-4} to 3×10^{-4} under average and maximum exposure scenarios. This risk is primarily due to the beryllium in groundwater, although bis(2-ethylhexyl)phthalate also contributes to the risk. Although the maximum concentration of beryllium is low (2.1 ug/l) it was included in this assessment because beryllium was not detected in samples from the background wells at a detection limit of 1.0 ug/l. It should be noted that beryllium has been assigned a cancer potency factor since completion of the EA performed during the RI report preparation. Beryllium previously had not indicated any potential health risks, but as a result of its recent classification as a carcinogen, beryllium now may pose potential health risks based on this revised EA. Additionally, bis(2-ethylhexyl)phthalate was added as a chemical of concern in groundwater during this EA. Bis(2-ethylhexyl)phthalate has had its cancer potency factor increased between the preparation of the original EA and this revised EA. Consequently, bis(2-ethylhexyl)phthalate also may pose potential health risks based on this revised EA. It should also be mentioned that neither beryllium nor bis(2-ethylhexyl)phthalate are known to be associated with waste pickle liquor. In evaluating the noncarcinogenic risk associated with future-use of the site, the hazard index is greater than one under the maximum assumptions evaluating ingestion of groundwater. This is primarily due to manganese, because the chronic daily intake for manganese exceeds the reference dose. Other chemicals that primarily contribute to the hazard index are cadmium, chromium, manganese and vanadium. All of these chemicals except for manganese contribute to the same toxic endpoint (the liver). It should be pointed out that residents in the vicinity of the site do not have private groundwater wells and it is therefore unlikely that groundwater would be developed as a source of drinking water in the future. Drinking water would more likely be provided by the City of Elyria public water supply.

Chemicals with acute AWQC values, maximum concentrations of copper, diethylphthalate and cadmium exceed maximum Ohio criteria and acute Federal criteria. Additionally, the maximum concentration of iron exceeds the acute Federal AWQC. Average concentrations of copper, mercury and diethylphthalate exceed the chronic AWQC and 30-day average concentrations for Ohio. The 30-day average concentration for iron in Ohio is exceeded by the average concentration of iron.

It should be noted for the surface water concentrations that all chemicals except barium, vanadium, manganese, cadmium, iron and nickel were calculated using the sediment/water partitioning model. The model is conservative and chemical concentrations in the water are not expected to be as large as those predicted by the model.

The primary purpose of the revised EA was to incorporate recent sampling results. At the same time, current toxicity values and ARARs were also applied. As a result of using current toxicity values, some chemicals presented a potential health risk in the revised EA that previously did not. The endangerment assessment has not been revised to conform to regulations and guidance which have been promulgated since the original endangerment assessment was completed. The reasons for continuing with the previous guidance procedures for the endangerment assessment are because: 1) the revised EA methods and procedures will be consistent with the original EA which served to direct further investigation activities at this site; 2) budgetary constraints prohibited the performance of this EA using new guidance

(because essentially an entirely new EA would have to be performed); and, 3) previous guidance generally utilizes more conservative assumptions for evaluating risks posed by the site, resulting in a more conservative assessment for protecting human health and the environment.

Although a formal sensitivity analysis has not been prepared, it is likely that the risks reported in this document are higher than if they had been calculated using current guidance. This factor should be taken into account by risk managers in the process of decision making at the Republic Steel Quarry site.

UNRESOLVED DATA NEEDS

Additional data on cadmium and copper concentrations in fish tissue would aid in evaluating current-use fish consumption exposure scenarios. It is anticipated that cadmium and copper concentrations would be lower in the fish tissue than predicted by the conservative modeling. As a result, the hazard index for fish consumption may be less than 1.

Additional data on beryllium and bis-2(ethylhexyl)phthalate concentrations in groundwater would aid in evaluating future-use groundwater consumption exposure scenarios.

CONCLUSIONS

Remedial Action and confirmatory sampling tasks specified in the Record of Decision (ROD) for the Republic Steel Quarry Site have been completed. Approximately 130 cubic yards of contaminated soil were removed and disposed in a regulated hazardous waste landfill. Groundwater was resampled and fish tissue samples were collected to better assess risks at the site. Risks posed under current- and future-use scenarios were reassessed in this report to establish revised risks after performance of the above tasks. No unacceptable health risks were identified under current-use exposure scenarios. The new fish tissue data showed that conservative uptake modeling performed in the Remedial Investigation (RI) Report had overestimated concentrations of mercury and manganese in fish tissue by an order of magnitude, which in turn overestimated the risks. By removing contaminated soils, risks posed by direct contact with soil were also decreased. Risks associated with direct contact with soils were also reduced to acceptable levels under the future-use scenarios because the contaminated soils were removed. Unacceptable risks were, however, identified under future residential use - ingestion of groundwater scenario. Another round of groundwater sampling demonstrated that methylene chloride was not present in the groundwater. Methylene chloride was a contaminant of concern in groundwater in the RI and drove a substantial portion of the groundwater ingestion risk. New toxicity information on bis(2-ethylhexyl)phthalate and beryllium, however, generated new risks which were not established during the RI.

This report documents that the objectives of the September 29, 1988 ROD have been accomplished; i.e., the soil removal and additional sampling show that the site poses acceptable risks except under the future-use ingestion of groundwater scenario. The next step in the process is for U.S. EPA and OEPA to determine if the groundwater problems at the Republic Steel Quarry warrant any further remedial action. The National Contingency Plan (NCP) gives the

Agencies some latitude in making these decisions. Considerations such as the likelihood that this groundwater will be used given the existence a municipal water supply and the extent of the beryllium contamination will be taken into account.

1.0 INTRODUCTION

1.1 PURPOSE OF INVESTIGATION AND REPORT

The United States Environmental Protection Agency (EPA) has performed a supplemental investigation at the Republic Steel Quarry site in Elyria, Ohio, to evaluate potential limited health risks identified during the Phase I remedial investigation (RI). The supplemental investigation was performed under authority of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and Superfund Amendments and Reauthorization Act (SARA). The primary objective of the supplemental investigation was to provide additional data for quantifying potential limited health risks identified by the Phase I RI. Results from supplemental investigation activities will be used to either support a site deletion petition to remove the site from the National Priorities List (NPL) or to identify public health risks posed by the site that require remedial measures to be undertaken.

The specific objectives of this supplemental investigation report are to:

- o Provide a summary of additional activities performed at the site following completion of the Phase I RI.
- o Provide additional data on the presence or absence of chemical contamination in surface soils, groundwater, and fish tissue at the site.
- o Revise the exposure and risk assessment for current use and future use conditions at the site to incorporate data collected during supplemental investigation activities into the exposure and risk evaluation.

The primary purpose of this revised endangerment assessment (EA) was to incorporate recent sampling results. At the same time, current toxicity values and ARARs were also applied. As a result of using current toxicity values, some chemicals present a potential health risk in this EA that previously did not. (For example, beryllium was assigned a cancer potency factor since completion of the original EA and now constitutes a potential health risk under future-use groundwater ingestion scenarios. It should be noted that Elyria City water is available surrounding this site and it is highly unlikely that groundwater would be utilized as a source of drinking water by future residents.) This endangerment assessment has not been revised to conform to regulations and guidance which have been promulgated since the original endangerment assessment was completed. The reasons for continuing with the previous guidance procedures for the endangerment assessment are because: 1) the revised EA methods and procedures will be consistent with the original EA which served to direct further investigation activities at this site; 2) budgetary constraints prohibited the performance of this EA using new guidance (because essentially an entirely new EA would have to be performed); and, 3) previous guidance generally utilizes more conservative assumptions for evaluating risks posed by the site, resulting in a more conservative assessment for protecting human health and the environment. In particular, the methodology and results in this EA do not reflect the National Contingency Plan promulgated in March 1990, EPA's Risk Assessment Guidance for Superfund, published in December 1989, and OSWE Direction 9850.4 on Interim Final

Guidance for Soil Ingestion Rates. Additionally, EPA currently recommends using an integrated uptake/biokinetic model for assessment of exposure to lead at Superfund sites. Although a formal sensitivity analysis has not been prepared, it is likely that the risks reported in this document are higher than if they had been calculated using current guidance. This factor should be taken into account by risk managers in the process of decision making at the Republic Steel Quarry site.

1.2 SITE BACKGROUND

1.2.1 Site Location and Description

The Republic Steel Quarry site is located east of West River Road and west of the West Branch of the Black River, directly across the river from Franklin School in Elyria, Ohio (see Figure 1-1). The City of Elyria is located southwest of Cleveland in Lorain County in northeastern Ohio. The site can be found on the Grafton USGS quadrangle map in Township 6 North, Range 17 West.

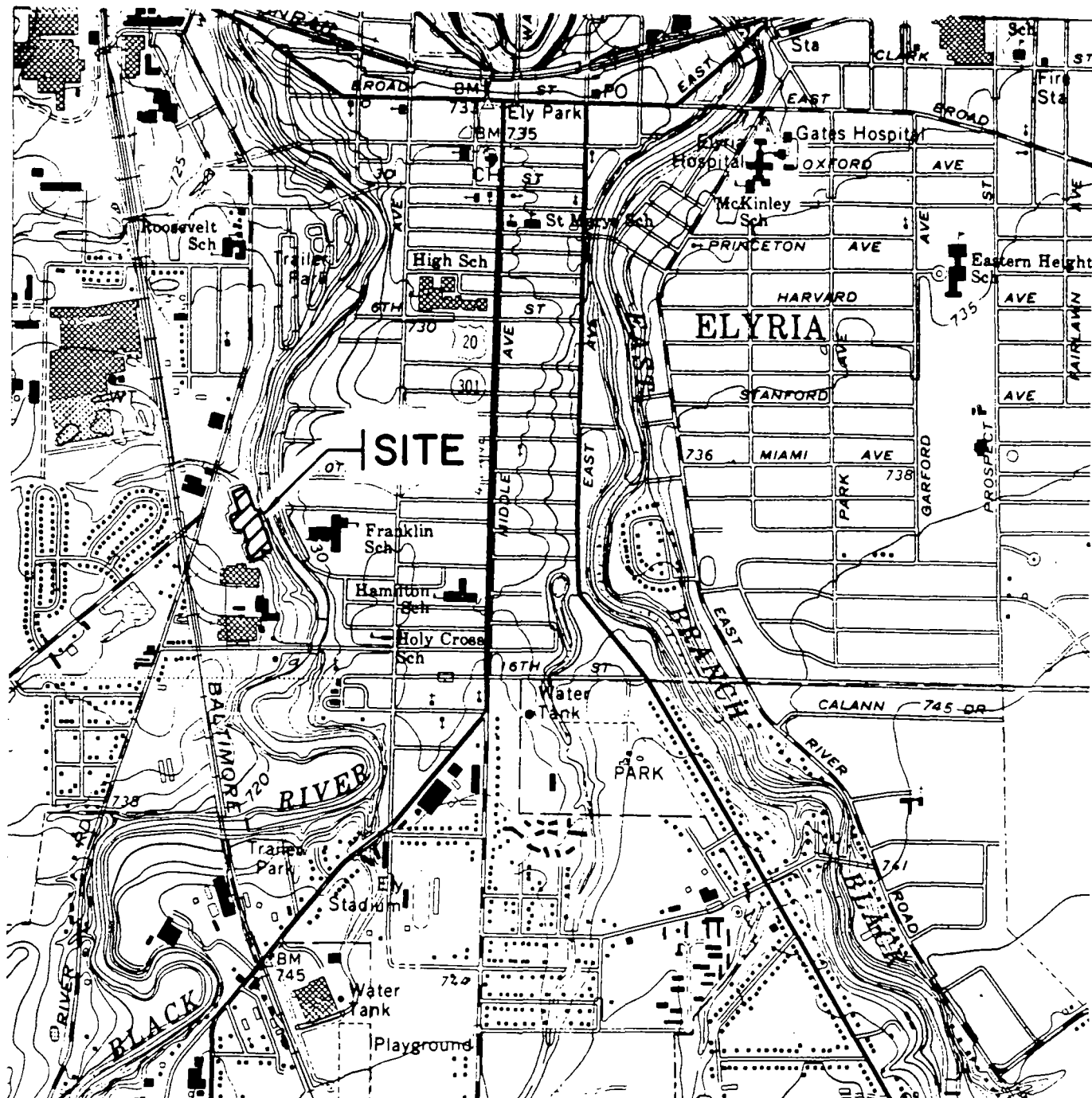
The site consists of a five acre quarry and the fenced area surrounding the quarry (see Figure 1-2). Water in the quarry has been measured at depths up to 62 ft. The sides of the quarry are nearly vertical and rise to an average of about 20 to 30 ft. above the quarry water surface elevation. The quarry walls are composed of in-place Berea Sandstone at and below the present water level. Above the sandstone, the quarry walls are composed of vertically stacked, large sandstone blocks. These blocks were placed during quarry operations as retaining walls to support the soil zone.

Although the site is fenced, it is still accessible through holes in the fence and areas where the bottom of the fence is 1 to 3 ft. above the ground surface. Water from the quarry discharges directly to the West Branch of the Black River. Water in the quarry is in direct contact with the Berea Sandstone formation which is a water supply aquifer in the area. Vegetation around the quarry perimeter is mostly grass and small brush; however, several larger trees can be found around the site and along the river. Vegetation is fairly dense over most of the site.

There are two hydraulic systems in the quarry. Concrete outlet works equipped with a gate valve are located along the east quarry wall where the elevation dips to about 704 ft. mean sea level (MSL). Water is usually draining from the outlet works into the river.

A 4 inch diameter steel pipe is located at the southeastern-most corner of the quarry extending down into the water. This pipe is believed to have been used for withdrawing water from the quarry to the Republic Steel plant, rather than being used for discharging the pickle liquor wastes. Neither system is apparently operational.

LTV Steel acquired Republic Steel Corporation, and is currently operating the steel plant located southwest of the quarry. There is an abandoned municipal landfill located about 0.6 miles northwest of the site. EPA closed this landfill several years ago. Land surrounding this landfill was flat, and this landfill was observed to have only a very slight mounding of the ground surface. Because of the surrounding land topography, it is thought that the



SOURCE: U.S.G.S. 7.5' TOPOGRAPHIC
MAP GRAFTON QUADRANGLE
OHIO, SCALE: 1" = 2000'.

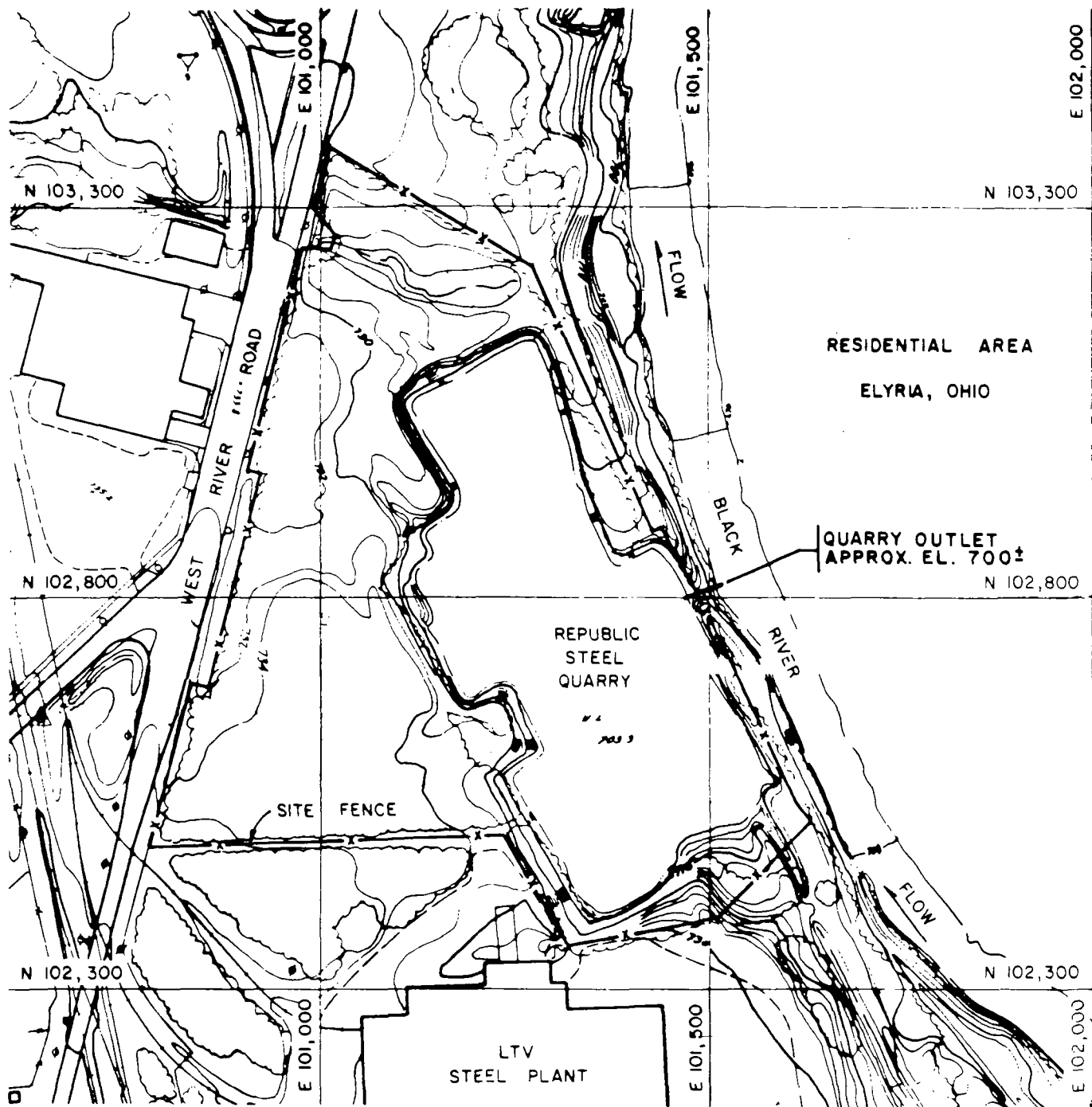


0 1540 3080
SCALE IN FEET



SITE LOCATION

FIGURE 1 - 1
SITE LOCATION MAP
REPUBLIC STEEL QUARRY SITE



SOURCE: CITY OF ELYRIA
ENGINEERING DEPARTMENT
SCALE: 1" = 100'



0 200 400
SCALE IN FEET

FIGURE 1-2
SITE MAP
REPUBLIC STEEL QUARRY SITE

wastes may have been disposed in a pit or quarry rather than in an above-ground landfill. There is also an industrial complex located 0.6 miles northwest of the site.

1.2.2 Site History

The Republic Steel Quarry site was operated as a sandstone quarry during an unknown period of time prior to 1950. Stone cut from the quarry was the Berea Sandstone, which was used as a building material.

From 1950 to 1972 Republic Steel Corporation discharged waste pickle liquor to the five acre quarry. The approximate volume of waste disposed into the quarry was estimated to be 200,000 gallons/year by Republic Steel personnel. The quarry water was sampled by Republic Steel Corporation in March and April of 1976. Stratified water quality was detected with the deeper waters having higher iron concentration and lower pH than shallower water. The pH of surface samples was approximately 7, while the pH of the quarry bottom samples was about 2. In 1977, the quarry was sold to the City of Elyria.

In 1981, Republic Steel Corporation notified EPA of the disposal activity under Section 103(C) of the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA). In response to Republic Steel's notification, Ecology and Environment, Inc. (E & E) performed a site investigation for EPA as its Field Investigation Team (FIT) contractor in late 1983 and installed three monitoring wells. Water samples were collected from the quarry and the monitoring wells. No organic contamination was detected at the site; however, heavy metals such as chromium, arsenic, lead, cadmium, magnesium, aluminum and iron were detected at significantly higher levels in the groundwater at one downgradient monitoring well than in the upgradient wells. The quarry water samples were collected from the surface and at depths of 10 ft., and only iron was detected at high concentrations.

The site was evaluated relative to the Hazard Ranking System in 1984. On October 15, 1984, EPA proposed that Republic Steel Quarry be included in Group II of the National Priorities List (NPL). IT Corporation (IT), at the request of LTV Steel, conducted an investigation of the site in November, 1984. Groundwater samples collected during this investigation detected higher concentrations of inorganics in the upgradient wells than in the downgradient wells. The quarry water samples collected had nearly neutral pH values (6.2 to 6.5), but were collected from only the surface and depths of 10 ft. This investigation concluded that EPA's Hazard Ranking System score should be recomputed based on evidence obtained in IT's investigation. This recomputed score, according to IT, would not be high enough for the site to be included on the NPL.

The results of the previously performed investigations were conflicting. The original investigation performed by Republic Steel detected potential hazards associated with the quarry water. The groundwater data collected by the FIT contractor concluded that groundwater contamination was probably occurring, while the PRP contractor's data concluded that no problem existed. Inconsistent groundwater sampling techniques could be the cause of the differences.

A remedial investigation was conducted by ICF Technology to confirm or refute the presence of site related environmental and public health hazards. A summary of the Phase I RI activities and findings is presented in Sections 1.2.3 through 1.2.5.

1.2.3 Summary of Phase I RI Activities

The field activities of the RI were performed from June through August, 1987. The major activities utilized to collect data during the RI included:

- o Profiling of quarry water quality and depth;
- o Performance of a magnetometer survey to identify metal objects on the quarry bottom;
- o Reconnaissance of quarry surface geology;
- o Chemical characterization of surface water from the quarry and the Black River;
- o Chemical characterization of sediment from the quarry and the Black River;
- o Chemical characterization of surface soils adjacent to the quarry;
- o Installation of eight monitoring wells and sampling of groundwater;
- o Property boundary research.

1.2.4 Major Findings of Phase I RI

Samples of surface water, sediments, surface soils and groundwater were collected and analyzed to estimate the types and extent of contamination due to the site. The conclusions with respect to the contamination of each media are included in the following items.

Surface Water: Surface water samples were collected from the quarry and Black River adjacent to the site during June 1987. Resampling was performed during March 1988 for semi-volatile organic analyses due to laboratory quality control problems that occurred during the initial analyses. To estimate the extent and nature of contamination, two analyses of the results were performed. Initially, the quarry water samples were compared to upgradient groundwater samples to identify potentially site related chemicals in the quarry. No organic chemicals were identified in the quarry water as being potentially site related. Several inorganic chemicals were identified as being potentially site related. All of these chemicals were detected at elevated concentrations compared to upgradient groundwater, with the greatest concentrations observed near the quarry bottom. The downstream Black River samples were compared to upstream river samples and quarry samples to estimate if the site was affecting river water quality. The results of this comparison indicated that the site was not adversely impacting Black River water quality.

Sediments: Sediment samples from the quarry and the Black River were collected in June 1987 and analyzed for organic and inorganic chemicals. The nature and extent evaluation for sediments was performed in two phases to determine if the quarry sediments were contaminated and to estimate if the quarry had adversely impacted the quality of Black River sediments. Initially, quarry sediments were compared to background soils to identify potentially site related chemicals. This analysis concluded that sediments within the quarry contain elevated levels of volatile and semi-volatile organic chemicals and inorganic chemicals. Volatile organic compounds were detected only in the deep quarry sediment samples (greater than 35 ft.) while semi-volatile organics and inorganics were detected in both deep and shallow samples. Concentrations of the inorganic and semi-volatile contaminants of the sediments obtained from deeper portions of the quarry were greater than those from the shallow sediments. The evaluation indicates that past activities at the site have affected quarry sediment quality.

A comparison of downstream Black River sediments to upstream river and quarry sediments was performed to estimate if the site is adversely impacting Black River sediments. The analysis indicated that no potentially site related organic or inorganic chemicals were detected in the sediments downstream. The site is not affecting sediments in the Black River.

Surface Soils: Surface soil samples were collected in June 1987. Analyses performed on surface soils obtained from areas of the site that are periodically inundated by quarry water or that were exposed to waste discharges in the past detected contaminants above background concentrations. Contaminants detected included volatile and semi-volatile organic chemicals and inorganic chemicals. Past disposal activities appear to have affected the quality of surface soils at the site. Semi-volatile organic chemicals and inorganic chemicals were also detected in a sample of the steel yard soils that are sliding into the quarry.

Groundwater: Eight monitoring wells were installed at or near the Republic Steel Quarry Site. All of these wells were sampled in August 1987 and two wells were resampled and analyzed for volatile organics in March 1988. Methylene chloride and acetone were detected at elevated concentrations in one downgradient monitoring well during August 1987. Resampling during March 1988 did not detect volatile organic contaminants at the downgradient monitoring well, suggesting that the acetone and methylene chloride found during August 1987 may have been due to laboratory or sampling procedure contamination. In an effort to be conservative during the endangerment assessment, these two volatile organic chemicals were considered present in groundwater at the site. Inorganic chemicals were detected in all downgradient wells adjacent to the site and in the well across the Black River; however, a direct connection to the site cannot be made to the inorganic chemicals in well B-8. Moreover, it is unlikely that contaminants from the quarry are passing beneath the Black River within groundwater since well B-8 is hydraulically upgradient from the site.

1.2.5 Phase I RI Endangerment Assessment Summary

The potential risks to human and environmental health attributed to chemicals present at the Republic Steel Quarry Site were evaluated in the Endangerment Assessment under a number of exposure scenarios. Potential pathways of

exposure to chemicals originating at the site under both current-use and hypothetical future-use conditions were examined.

Under current-use conditions, the only exposure scenario resulting in a greater than 10^{-6} risk is the maximum case for ingestion of fish. This risk is primarily due to carcinogenic PNAs which were conservatively estimated using the sediment/surface water exposure model. Additionally, this maximum exposure scenario results in a total noncarcinogenic hazard index greater than one due primarily to mercury and manganese. This risk is based on modeling using very conservative assumptions. Combined risks to trespassers, assuming the same person would be exposed to soil through direct contact with incidental ingestion, quarry water through swimming, and fish through ingestion were estimated. The combined upper bound excess lifetime cancer risks are 3×10^{-8} to 4×10^{-6} under average and maximum exposure conditions. The combined hazard index is less than one under the average scenario and greater than one under the maximum scenario.

Under future-use conditions the exposure scenarios evaluated that resulted in a greater than 10^{-6} upperbound excess lifetime cancer risk are maximum exposure to future residents through direct contact and incidental ingestion of soil, and average and maximum exposure via ingestion of groundwater. Consequently the combined potential residential risk is 2×10^{-6} to 5×10^{-5} under average and maximum exposure scenarios. It should be noted that the risk from exposure to contaminants in soil is primarily due to exposure to cPNA's, which were detected primarily at one area of the site (the south boat launch) and which are ubiquitous in the environment. The exposure scenario for ingestion of groundwater assumed methylene chloride and acetone were present in groundwater, although the presence of these contaminants was not confirmed during a subsequent groundwater sampling effort. In evaluating the combined noncarcinogenic risk, the hazard index is greater than one under the maximum exposure scenarios. However, none of these noncarcinogenic chemicals in groundwater, have chronic daily intakes that exceed available criteria. In addition, each of the chemicals of potential concern with the highest CDI:RfD ratios have different end points of toxicity. Therefore, impacts from ingestion of noncarcinogenic chemicals are not expected.

1.3 REPORT ORGANIZATION

The remainder of this report presents the scope of the supplemental investigation, and the findings and conclusions as a result of its implementation. The supplemental investigation report is organized as follows:

SECTION 2.0, FISH SPECIES SURVEY/FISH TISSUE SAMPLING INVESTIGATION, presents findings of the fish species survey and fish tissue sampling activities performed at the site. Analytical results, an evaluation of fish tissue contamination extent, and conclusions are also presented.

SECTION 3.0, EPA EMERGENCY RESPONSE SECTION SOIL REMEDIAL ACTIVITIES, discusses soil sampling activities performed by EPA ERS to delineate the extent of soil contamination along the south bank of the quarry and in the pickle liquor ditch. Sampling locations, sampling method, and laboratory analytical results are presented. Additionally, soil removal activities and post-removal confirmation sampling results are given.

SECTION 4.0, GROUNDWATER RESAMPLING INVESTIGATION, details the October 1988 groundwater resampling activities performed to confirm or refute the presence of methylene chloride and acetone in downgradient groundwater. This section describes sampling location and sampling method, summarizes analytical results from the resampling program, evaluates the nature and extent of groundwater contamination and presents conclusions.

SECTION 5.0, REVISED ENDANGERMENT ASSESSMENT, incorporates data from the supplemental investigation and characterizes existing and potential future effects of chemicals present at the site. The assessment includes identification of potential receptors, and public health and environmental impacts.

SECTION 6.0, REFERENCES, documents resources used in preparing this Supplemental Report.

2.0 FISH SPECIES SURVEY/FISH TISSUE SAMPLING INVESTIGATION

2.1 INTRODUCTION

The Phase I RI Endangerment Assessment (EA) concluded that the only current-use exposure scenario resulting in a greater than 10^{-6} excess lifetime cancer risk was the maximum exposure condition for ingestion of fish from the quarry. This risk was primarily due to carcinogenic PNAs that were conservatively estimated using the sediment/surface water exposure model. Although the Phase I RI EA noted that PNAs are metabolized by fish, to be conservative, the risks posed by fish ingestion were not reduced to account for PNA metabolism.

Following completion of the Phase I RI EA, USEPA and the REM IV team attempted to identify analytical methods for quantifying the level of carcinogenic PNAs in quarry fish tissue. Based on conversations with personnel from the National Fisheries Contaminant Research Center, U. S. Fish and Wildlife Service, and National Oceanic and Atmospheric Administration (NOAA), and a review of published literature, USEPA, Ohio EPA and the REM IV team concluded that detectable levels of PNAs will not be present in fish tissue at the Republic Steel Quarry site because PNAs will be metabolized by the fish. Because the PNAs are metabolized by the fish and detectable concentrations of PNAs in fish tissue samples are not expected, ingestion of fish tissue is not anticipated to cause unacceptable carcinogenic health risks. No other organic compounds were determined to pose a significant health risk in the Endangerment Assessment.

The maximum exposure condition for the current-use scenario also resulted in a total noncarcinogenic hazard index greater than one. The noncarcinogenic hazards were posed primarily by mercury and manganese. Therefore, USEPA, Ohio EPA, and the REM IV team concluded that manganese and mercury concentrations in fish tissue should be evaluated to estimate the noncarcinogenic health hazards posed by fish tissue ingestion.

A fish community survey was performed by ASC and ICF personnel on August 7 through 10, 1989 to provide data on the numbers and types of fish that inhabit the quarry and Black River near the site. The fish community survey provided information on species composition and relative abundance.

Sixteen fish tissue samples and one whole body sample were prepared on August 11, 1989 at the Aquatic Systems Corporation (ASC) laboratory using fish collected from the quarry and the Black River, upstream from the Mussey Avenue dam and downstream from the quarry outfall. The Black River tissue samples serve as risk comparison samples in this study, since the 1987 Remedial Investigation indicated that the site was not adversely impacting the water quality or sediments in the Black River. The seventeen fish samples were overnight expressed to a CLP laboratory, where they were analyzed for manganese, mercury, and percent lipids. ASC assisted in the preparation of Sections 2.1, 2.2 and 2.3 of this Supplemental Report.

2.2 FISH COMMUNITY SURVEY RESULTS

The fish species collected in the survey of the quarry and Black River are presented in Table 2-1. Eighteen fish species, representing four families

TABLE 2-1
FISH SPECIES COLLECTED FROM REPUBLIC STEEL QUARRY
AND BLACK RIVER ON AUGUST 8 THROUGH 10, 1989

<u>Common Name</u>	<u>Scientific Name</u>
(Carps and Minnows)	Cyprinidae
Central stoneroller	<u>Campostoma anomalum</u>
Common carp	<u>Cyprinus carpio</u>
Golden shiner	<u>Notemigonus crysoleucas</u>
Striped shiner	<u>Notropis chrysocephalus</u>
Spotfin shiner	<u>Notropis spilopterus</u>
Sand shiner	<u>Notropis stramineus</u>
Bluntnose minnow	<u>Pimephales notatus</u>
Creek chub	<u>Semotilus atromaculatus</u>
(Suckers)	Catostomidae
White sucker	<u>Catostomus commersoni</u>
(Bullhead catfishes)	Ictaluridae
Black bullhead	<u>Ictalurus melas</u>
Yellow bullhead	<u>Ictalurus natalis</u>
Brown bullhead	<u>Ictalurus nebulosus</u>
(Sunfishes)	Centrarchidae
Green sunfish	<u>Lepomis cyanellus</u>
Pumpkinseed	<u>Lepomis gibbosus</u>
Bluegill	<u>Lepomis macrochirus</u>
Smallmouth bass	<u>Micropterus dolomieu</u>
Largemouth bass	<u>Micropterus salmoides</u>
White crappie	<u>Pomoxis annularis</u>

were collected in the survey. Table 2-2 presents quantitative data for fish species collected at each sampling location according to the sampling methodology used.

The fishes collected in the survey were noted by field personnel to be robust and of good coloration. There were no signs of excess mucus production, nodular growths, reddened areas, or fungus on the surface of the fishes collected. No other signs of stress were observed.

Quarry

A total of 34 fish, representing seven species and four families, were collected from the quarry gill nets during the three day period they were set. Green sunfish and Bluegill (Centrarchidae) accounted for 65% of the total catch. Brown bullhead and Black bullhead (Ictaluridae) comprised 21% of the catch. The largest fish collected from the quarry was a carp, total length of 512 mm. The majority of fish were collected from the gill nets positioned in the shallow waters at the southwest corner of the quarry, close to the island.

The Green sunfish was the only species of fish collected by electrofishing in the quarry. A total of eight Green sunfish were caught ranging in length from 67 mm to 120 mm. All fish were caught at the surface close to shore.

Black River - Below Outfall

A total of 302 fish, representing 14 species and four families were collected by electrofishing the Black River below the quarry outfall. Cyprinids (Carp and Minnows) accounted for 78% of the total catch, with the Sand shiner being the most numerous species. Smallmouth bass (total length range 166 mm - 267 mm) and Largemouth bass (total length range 131 mm - 222 mm) were collected from the Black River below the outfall.

Black River - Above Outfall, Below Dam

A total of 214 fish, representing ten species and three families were collected by electrofishing the Black River from the quarry outfall, upstream to the dam. The results of the survey suggest that the fish community is very similar in species composition above the quarry outfall (below Mussey Avenue dam) and below the quarry outfall.

Black River - Above Mussey Avenue Dam

Fifty-one fish, representing eight species and three families were collected above the dam using electrofishing and seining techniques. It should be noted that the dam is approximately six feet high, and would prevent fish from swimming from below the dam to above the dam. The habitat upstream from the dam consisted of deep pools, while the downstream habitat consisted of pools and riffles. The Sand shiner and Bluntnose minnow which were numerous in the downstream collections were not collected upstream from the dam. Differences in the fish community are probably attributable to differences in physical habitat (e.g., water depth, velocity and substrate). Based on the results of this sampling effort, it would appear that the fish community is not being adversely affected by the discharge of the quarry into the Black River. However, a more in-depth investigation into the total ecological system (e.g.,

TABLE 2-2
QUANTITATIVE DATA FOR FISH SPECIES COLLECTED FROM
REPUBLIC STEEL QUARRY AND BLACK RIVER ON AUGUST 8 THROUGH AUGUST 10, 1989

Fish Species	LOCATION AND SAMPLING METHOD					
	QUARRY		BLACK RIVER			
	GN	EF	BELOW OUTFALL	ABOVE OUTFALL BELOW DAM	ABOVE DAM	
			EF	EF	EF	S
Central Stoneroller	0	0	12	7	0	0
Common Carp	1	0	4	0	2	0
Golden Shiner	1	0	1	0	0	6
Striped Shiner	0	0	39	22	0	0
Spotfin Shiner	0	0	1	0	0	0
Sand Shiner	0	0	113	106	0	0
Bluntnose Minnow	0	0	51	47	0	0
Creek Chub	0	0	15	7	0	0
White Sucker	3	0	47	17	2	0
Black Bullhead	3	0	0	0	0	0
Yellow Bullhead	0	0	1	0	0	0
Brown Bullhead	4	0	0	0	0	0
Green Sunfish	13	8	7	0	2	2
Pumpkinseed	0	0	0	0	0	1
Bluegill	9	0	1	2	1	5
Smallmouth Bass	0	0	7	2	0	0
Largemouth Bass	0	0	3	3	5	3
White Crappie	0	0	0	1	1	21
Total Number of Species	7	1	14	10	6	6
Total Number of Fish	34	8	302	214	13	38

GN - Gill Net, EF - Electrofishing, S - Seine

benthic macroinvertebrate and periphyton) may reveal stresses that were not identified during this investigation.

2.3 FISH SAMPLING LOCATIONS AND METHODS

2.3.1 Fish Sampling Locations and Methodology

2.3.1.1 Quarry

The quarry was sampled for fish using experimental gill nets and electrofishing methods. Gill nets were initially set in the quarry on the afternoon of August 7, 1989. Eight 125 ft., six panel gill nets (1/2", 1", 2", 2 1/2", 3", and 3 1/2" panels) and two 250 ft. gill nets (1", 1 1/2", 2", and 2 1/2" panels) were initially set in the locations shown in Figure 2-1. The ten nets were set at these locations in an attempt to collect fish from surface waters, intermediate zones, and the deepest sections of the quarry.

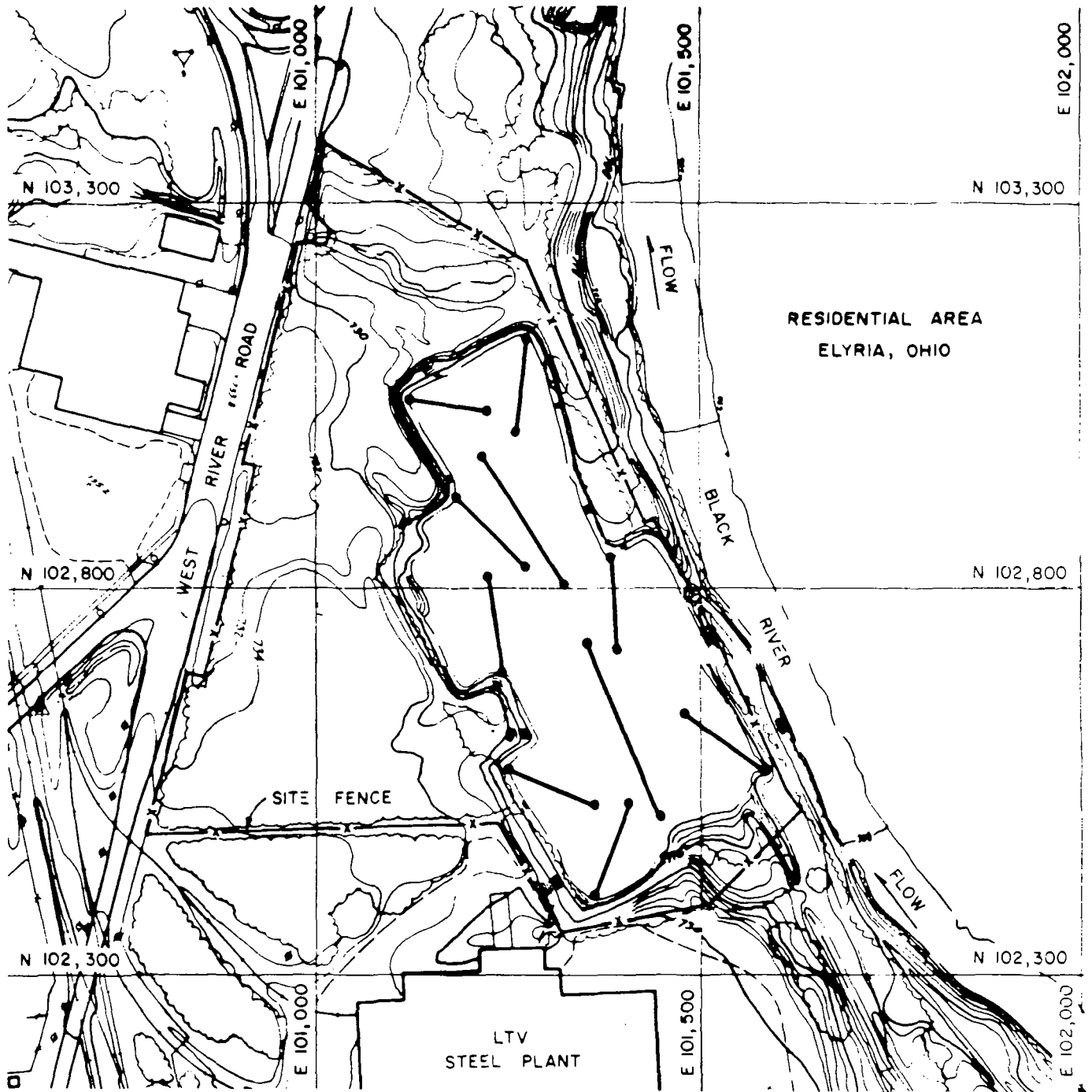
The ten gill nets were checked on the morning of August 8, 1989. No fish were collected from the nets located in the deeper sections of the quarry. The nets were subsequently reset near the surface either by tying the end(s) of the float line to the shore and/or small island or by attaching additional buoys to the float lines of nets located in the middle of the quarry.

A dissolved oxygen/temperature profile was performed at the deepest section of the quarry on the morning of August 8, 1989. Water samples were collected at the surface and at ten foot intervals to a maximum depth of 60 feet using a Kemmerer water sampler. Dissolved oxygen was measured using the azide modification of the Winkler Method as outlined in Standard Methods for the Examination of Water and Wastewater. The quarry was thermally stratified, and the thermocline occurred between 20 and 30 feet at this location, where the dissolved oxygen dropped from 8.7 ppm to 0.3 ppm.

The gill nets were checked for fish during the early afternoon of August 9, 1989. The ten nets were then reset in the same general area as the previous day, but slightly repositioned. Two additional 125 ft. gill nets were set in the southwestern corner of the quarry between the small island and the shoreline, because this was the area where the greatest number of fish were being collected. The gill nets were again checked and pulled from the quarry on the morning of August 10, 1989.



The quarry was also sampled for fish using boat mounted electrofishing equipment, since few fish were initially collected in the gill nets. Electric current was supplied to two spherical probes composed of one inch copper strips. Each probe was supported at the end of a boom extending from the bow of the boat. A 750 watt portable generator supplied electricity to a control box which produced 110 volt A.C. output at 60 Hz frequency. Foot safety switches were used to control the flow of current from the control box to the probes.

Electrofishing was performed at the quarry on August 8 (afternoon) and August 10 (morning) 1989. One complete lap around the shoreline of the quarry was made during each survey.



SOURCE: CITY OF ELYRIA
ENGINEERING DEPARTMENT
SCALE: 1" = 100'

LEGEND

-  125 FT. LENGTH GILL NET
-  250 FT. LENGTH GILL NET

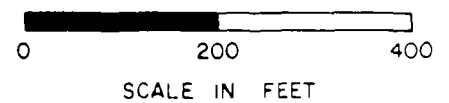


FIGURE 2-1
FISH SAMPLING/GILL NET
LOCATIONS
REPUBLIC STEEL QUARRY SITE

2.3.1.2 Black River - Above Dam

A six foot high dam was located approximately 1000 feet above the outfall from the quarry. This dam prevents fish from swimming from below to above the dam. Upstream from the dam the Black River varied in depth from 6 - 15 ft. and had an average width of 100 feet. The shorelines were lined with numerous trees and vegetation which extended over the water. Water visibility was limited to two feet below the surface.

Electrofishing was conducted upstream from the dam on the evenings of August 8 and 9, 1989 using boat mounted electrofishing equipment. Both shorelines extending for approximately 2000 feet above the dam, were electrofished on both days.

Seining methods were also used to collect fish above the dam on the Black River on the evening of August 8, 1989. An eighty foot haul seine (mesh size 1/4") was used to collect fish from a shallow area (3 - 6 ft. deep) located approximately 500 feet above the dam. The 14 ft. work boat was initially used to extend the seine across the river, then utilized to pull the free end back to the shore. The remainder of the seine was pulled in by hand, trapping the fish. The seining procedure was performed twice at this location.

2.3.1.3 Black River - Above and Below Quarry Outfall

The depth of the Black River below the dam varied from one foot at riffles, to 3 - 6 feet in the pools. The average river width below the dam was 100 feet. There were less trees and vegetation extending from the shore over the water compared to above the dam. The undersides of rocks appeared to offer the most cover for the fish.

Electrofishing was conducted on the Black River below the dam on the morning of August 9, 1989. The 14 ft. electrofishing boat could not be used due to the shallow depth. A battery-powered backpack shocker was placed inside an eight ft. boat. Circular aluminum electrodes equipped with safety switches on the insulated fiberglass handles were connected to the backpack shocker by way of insulated electrical leads. The boat was moved and stabilized by one person as the two people holding the electrodes progressed upstream. All personnel performing electrofishing wore cotton glove liners, heavy rubber gloves, and chest waders. Two buckets lined with plastic were placed in the wading boat to hold the fish collected in the dip nets.

The section of the Black River downstream from the quarry outfall was electrofished prior to the upstream section on August 9, 1989. Approximately 1500 ft. of river downstream from the outfall was electrofished. An approximately 1000 foot length of the Black River from the quarry outfall upstream to the base of the dam was electrofished.

2.3.2 Field Processing of Fish Samples

Fish were collected in the survey using a seine, gill nets, and electrofishing techniques. All fish were processed in the field as soon as possible after the time of collection. Field processing consisted of weighing, measuring, and identifying the fish to species level. The fish were identified by

trained personnel using published references, including Trautman's Fishes of Ohio.

The fish were placed in groups by species on a clean aluminum foil surface (dull side up) following identification and measurement. A subset of at least five fish (when possible) of the same species and approximately the same length and weight, which were representative of the majority of the fish of that species, were selected for tissue analysis. Once a subset was selected, the fish were wrapped in aluminum foil (dull side toward the fish), secured with duct tape, and marked with the sample identification number using a permanent marker. The fish packages were placed in coolers containing dry ice, which were closed and custody sealed until returned to the ASC facility.

Upon arrival at ASC, the fish samples were removed from the coolers and placed in plastic lined tubs where they thawed overnight prior to laboratory processing the next day. The building's security system was activated overnight until processing could begin.

One whole fish of each species collected in the survey was vouchered and placed in a 10% formaldehyde solution (with the exception of Black bullhead which were all needed for tissue analysis). These fish vouchers will be retained for a two year period to allow for fish species confirmation, if deemed necessary.

2.3.3 Laboratory Processing - Fish Samples

The laboratory processing of fish samples was performed at the ASC facility on August 11, 1989. The sampling plan for the Fish Community Survey and Tissue Sampling at the quarry presented proposed sample descriptions. These proposed sample descriptions were modified because bass species were not collected from the quarry and also due to the limited size and quantity of fish collected from the quarry. Table 2-3 presents the sample descriptions as sent to the CLP laboratory for analysis.

Ten rainbow trout (Salmo gairdneri) were obtained from the Laurel Hill Trout Farm located in Donegal, Pennsylvania on August 10, 1989 for use in the preparation of the two blank samples. These fish were handled in the same manner as the fish collected in the field. The fish were wrapped in aluminum foil (dull side up), then frozen in a cooler containing dry ice. The fish were removed later in the day and permitted to thaw overnight prior to laboratory processing.

Sample preparation/homogenization equipment such as blenders, grinders, mixing bowls, and filleting knives were carefully decontaminated before the preparation of each fish sample. Work surfaces that were in contact with fish were covered with clean aluminum foil between each sample. The decontamination procedure consisted of the following steps:

1. Equipment scrubbed with a trisodium phosphate soap solution
2. Potable water rinse
3. Rinse with a solution of 10% nitric acid in distilled water
4. Thorough rinse with distilled water.

TABLE 2-3
FISH TISSUE SAMPLE DESCRIPTIONS

<u>Sample No.</u>	<u>Sample Description</u>	<u>Sampling Location</u>	<u>Number of Fish Used to Prepare Samples</u>	<u>Total Sample Volume</u>
RSQ-FT-001	Carp (MS/MSD)	Quarry	1	24 oz.
RSQ-FT-002	Trout	Blank	5	16 oz.
RSQ-FT-003	Trout	Blank	5	16 oz.
RSQ-FT-004	Brown Bullhead Catfish	Quarry	3	10 oz.
RSQ-FT-005	White Suckers	Upstream	2	8 oz.
RSQ-FT-006	White Suckers	Quarry	2	4 oz.
RSQ-FT-007	Small Mouth Bass	Downstream	3	8 oz.
RSQ-FT-008	Small Mouth Bass (Duplicate of FT-007)	Downstream	4	8 oz.
RSQ-FT-009	Large Mouth Bass	Downstream	2	6 oz.
RSQ-FT-010	Large Mouth Bass	Upstream	4	14 oz.
RSQ-FT-011	Carp	Upstream	2	8 oz.
RSQ-FT-012	Carp	Downstream	2	8 oz.
RSQ-FT-013	White Suckers	Downstream	6	16 oz.
RSQ-FT-014	White Suckers (MS/MSD) (Duplicate of FT-013)	Downstream	11	30 oz.
RSQ-FT-015	Bluegill and Green Sunfish	Quarry	9 BG 17 Sun	8 oz.
RSQ-FT-016	Crappies	Upstream	22	16 oz.
RSQ-FT-017	Black Catfish	Quarry	3	3 oz.

NOTES: All samples, with the exception of RSQ-FT-001, were composite samples. RSQ-FT-001 was not a composite sample because only one carp was obtained from the quarry.

Upstream samples were prepared using fish collected above the Mussey Avenue Dam, and do not include any fish from below the dam. Downstream samples were prepared from fish collected below the quarry outlet to the Black River.

The fish previously selected for the preparation of samples were allowed to thaw overnight prior to filleting. In the preparation of a fish tissue sample, the fish were scaled, then filleted (with the skin remaining). The filleted portions were placed in a decontaminated blender and homogenized. The whole body sample was prepared using a one HP, stainless steel, commercial food grinder. The homogenized fish sample was placed into two 8 ounce jars (when a sufficient amount was available), allowing a half inch space at the top of the jars for expansion.

A properly completed sample tag was attached to each sample jar. After each sample jar was tagged it was placed in an air tight plastic bag, then frozen in a cooler containing dry ice. Simultaneously, the necessary Special Analytical Services packing lists, chain-of-custody forms, and custody seals used for CLP sample tracking and records were completed as outlined in Appendix A-1 of the Sampling Plan.

The seventeen frozen fish samples were prepared for shipment to the CLP laboratory following the packing and shipping procedures outlined in Appendix A-1 of the Sampling Plan. The fish samples were shipped overnight express to the CLP laboratory on August 11, 1989.

2.4 LABORATORY ANALYSES PERFORMED AND RESULTS

All fish tissue samples were analyzed for manganese, mercury and percent lipids. Analytical results are presented in Table 2-4.

2.5 FISH TISSUE CONTAMINATION EVALUATION

Fish tissue concentrations were evaluated first by examining results from a particular species at upstream, downstream and quarry locations. Due to the limited number of species that were caught at each location, a second analysis was performed to look at average concentrations in all fish tissue samples at the upstream, downstream, and quarry locations. The second analysis permitted fish of different species to be combined in the average concentration calculations. The second analysis has significant limitations because grouping different species together and evaluating the fish tissue analytical results ignores the fact that different species will have different percent lipids content and different absorption characteristics for mercury and manganese.

Table 2-5 shows a summary of the fish tissue evaluation by species. Quarry and downstream carp samples displayed elevated levels of percent lipids, manganese and mercury compared to upstream carp samples. Quarry and downstream white sucker samples detected higher levels of manganese than found in upstream white sucker samples; however, percent lipids and mercury concentrations in the white suckers were lower downstream and in the quarry than upstream. Large mouth bass were observed to have higher levels of manganese, mercury, and higher percentages of lipids in the downstream sample than in the upstream sample.

Table 2-6 presents the fish tissue evaluation by location. The two blank samples (trout) detected manganese and mercury at low levels. Because the blanks were actual fish tissue samples that probably contained the metals prior to sample processing, blank samples will not be used as a means to

TABLE 2-4
FISH TISSUE SAMPLE ANALYTICAL RESULTS

<u>SAS Number</u>	<u>Sample No.</u>	<u>Sample Description</u>	<u>Sampling Location</u>	<u>Number of Fish Used to Prepare Samples</u>	<u>Percent Lipids</u>	<u>Manganese Concentration (mg/kg)</u>	<u>Mercury Concentration (mg/kg)</u>
4840E-01	RSQ-FT-001	Carp (MS/MSD)	Quarry	1	2.62	0.27	0.345
4840E-02	RSQ-FT-002	Trout	Blank	5	5.79	0.24	0.151
4840E-03	RSQ-FT-003	Trout	Blank	5	5.10	0.19	0.037
4840E-04	RSQ-FT-004	Brown Bullhead Catfish	Quarry	3	7.00	0.20	0.453
4840E-05	RSQ-FT-005	White Suckers	Upstream	2	1.81	0.28	0.274
4840E-06	RSQ-FT-006	White Suckers	Quarry	2	0.91	0.43	0.059
4840E-07	RSQ-FT-007	Small Mouth Bass	Downstream	3	0.76	0.20	0.218
4840E-08	RSQ-FT-008	Small Mouth Bass (Duplicate of FT-007)	Downstream	4	0.98	0.29	0.438
4840E-09	RSQ-FT-009	Large Mouth Bass	Downstream	2	0.84 0.81 (Lab Dupe)	0.31	0.368
4840E-10	RSQ-FT-010	Large Mouth Bass	Upstream	4	0.44	0.14 (Lab Dupe 0.136)	0.277 (Lab Dupe 0.275)
4840E-11	RSQ-FT-011	Carp	Upstream	2	0.99	0.29	0.172
4840E-12	RSQ-FT-012	Carp	Downstream	2	0.95	0.21	0.104
4840E-13	RSQ-FT-013	White Suckers	Downstream	6	0.74	0.91	0.303
4840E-14	RSQ-FT-014	White Suckers (MS/MSD) (Duplicate of FT-013)	Downstream	11	0.94 0.91 (Lab Dupe)	1.04	0.131
4840E-15	RSQ-FT-015	Bluegill and Green Sunfish	Quarry	9 BG 17 Sun	1.55	3.73	0.163
4840E-16	RSQ-FT-016	Crappies	Upstream	22	3.60	0.39	0.095
4840E-17	RSQ-FT-017	Black Catfish	Quarry	3	0.46	0.64 (Lab Dupe 0.692)	0.085 (Lab Dupe 0.113)

TABLE 2-5

FISH TISSUE EVALUATION BY SPECIES

<u>Sample Description</u>	<u>Sample Location</u>	<u>% Lipids</u>	<u>Manganese (mg/kg)</u>	<u>Mercury (mg/kg)</u>
Carp	Quarry	2.62	0.27	0.345
	Upstream	0.99	0.29	0.172
	Downstream	0.95	0.21	0.104
White Suckers	Quarry	0.91	0.43	0.059
	Upstream	1.81	0.28	0.274
	Downstream (Ave)	0.83	0.98	0.217
Large Mouth Bass	Upstream	0.44	0.138	0.276
	Downstream	0.83	0.31	0.368

TABLE 2-6
FISH TISSUE EVALUATION BY LOCATION

<u>Sample Location</u>	<u>Arithmetic Mean</u>
<u>Percent Lipids</u>	
Quarry	2.51
Blank (Trout)	5.45
Upstream	1.71
Downstream	0.86
<u>Manganese</u>	
Quarry	1.06 mg/kg
Blank (Trout)	0.22 mg/kg
Upstream	0.27 mg/kg
Downstream	0.49 mg/kg
<u>Mercury</u>	
Quarry	0.22 mg/kg
Blank (Trout)	0.09 mg/kg
Upstream	0.20 mg/kg
Downstream	0.26 mg/kg

1. Lab duplicates were similar so results were treated as only 1 sample.
2. Field duplicates varied significantly due to natural variation in metals concentrations in the fish and field duplicates were treated as separate samples in calculations.
3. Fish of different species were combined in performing these calculations. All fish samples collected were used in determining the arithmetic mean values. It should be noted that fish of different species will have different percent lipids content and different absorption characteristics for mercury and manganese.

prevent the metals from being identified as site related chemicals. Based on Table 2-6, percent lipids were highest in fish collected from the quarry, but lower in downstream samples than upstream samples. Fish tissue samples from the quarry and downstream were found to contain higher levels of manganese and mercury than upstream samples.

2.6 CONCLUSIONS

As a result of the elevated concentrations of mercury and manganese in fish tissue samples from the quarry and downstream compared to upstream samples, mercury and manganese will be retained as chemicals of concern and will be included in the Endangerment Assessment, Section 5 of this Supplemental Report. It should be noted that the concentrations of mercury and manganese present in the fish are significantly below the concentrations predicted from the conservative modeling used for preparing the original endangerment assessment.

3.0 EPA EMERGENCY RESPONSE SECTION SURFACE SOILS INVESTIGATION

3.1 INTRODUCTION

Based on the Phase I RI findings, the Record of Decision (ROD) concluded that approximately 100 cubic yards of contaminated soils should be removed from the south end of the quarry, due to low concentrations of polynuclear aromatic hydrocarbons (PNAs) detected in soils from the pickle liquor discharge ditch and boat launch areas.

The two potentially responsible parties (PRPs) were sent special notice letters on February 17, 1989 to pay for the removal of the contaminated soils, however, the PRPs did not offer to perform the work. The two PRPs identified are LTV Steel and the City of Elyria. LTV currently owns the steel plant and the south side of the pickle liquor discharge ditch. The City of Elyria owns the quarry and the boat launch area, as well as the north side of the pickle liquor discharge ditch.

On June 6, 1989, the PRPs were notified that negotiations were terminated and that EPA intended on performing the Remedial Design/Remedial Action (RD/RA) at the site.

3.2 SITE ASSESSMENT ACTIVITIES

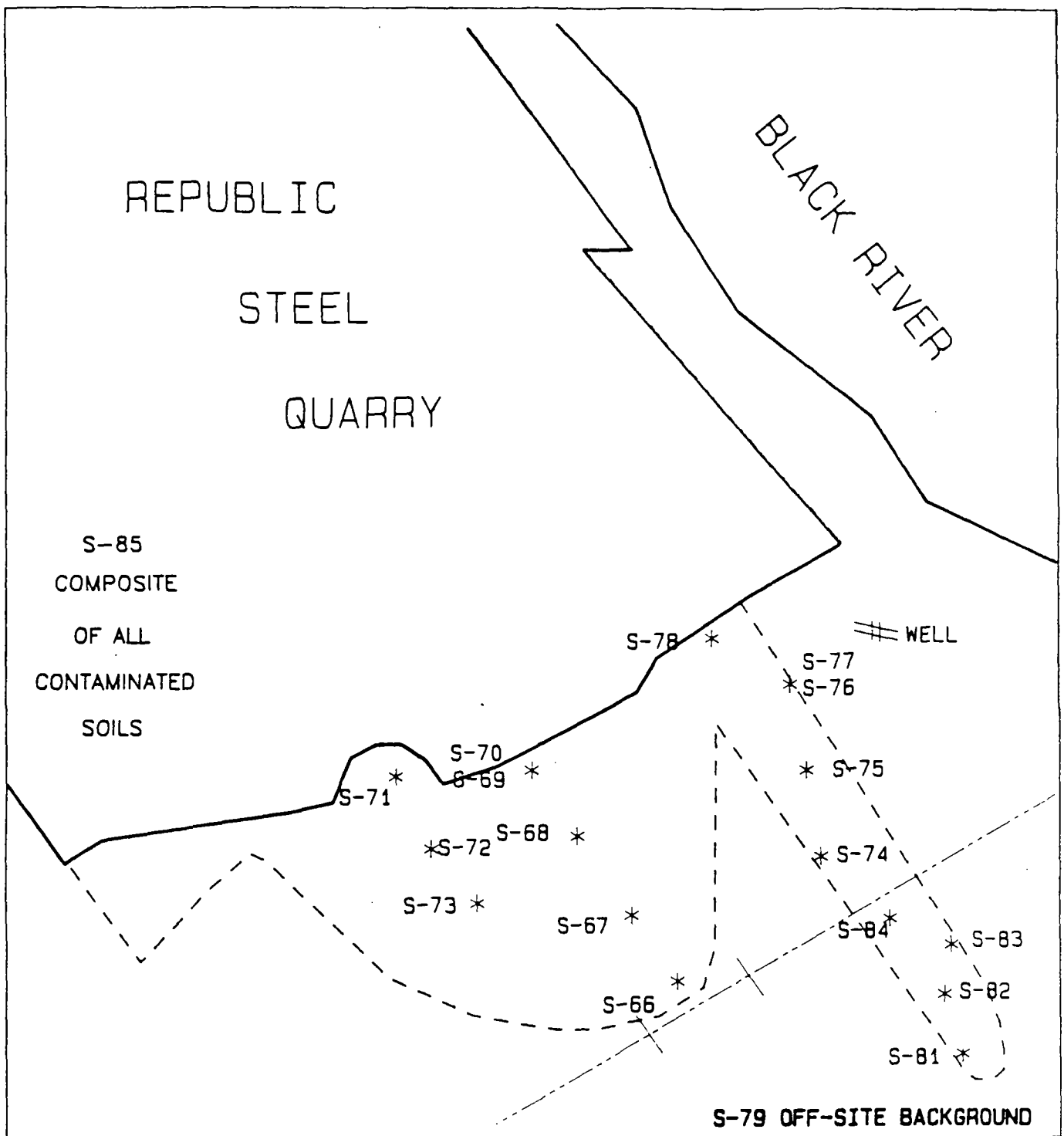
EPA requested that the Technical Assistance Team (TAT) collect verification samples in order to confirm the need for the soil removal and to delineate the extent of the soil contamination. Samples were collected on August 8, 1989 and submitted to Grace Analytical Laboratories. A total of nineteen grab samples were collected, including two duplicate samples and two background samples. The nineteen grab samples were analyzed for base neutral and acid extractable organics (BNAs). Additionally, two composite samples were collected and analyzed for disposal parameters and Extraction Procedure (EP) Toxicity for metals.

3.2.1 Surface Soil Sampling at Boat Launch Area

Eight grab samples, including one duplicate, were collected from the boat launch area (sample numbers S-66 through S-73). Sampling locations are presented on Figure 3-1. Sampling depths ranged from 2 inches to 8 inches. TAT extrapolated water level marks noted on the Berea sandstone to estimate what portion of the boat launch area would be inundated during high water periods and selected sampling locations to cover this area.

3.2.2 Surface Soil Sampling in Pickle Liquor Discharge Ditch

Nine samples, including one duplicate sample, were collected at 20-foot intervals in a sequential pattern alternating from one side of the ditch to the bottom and then across to the opposite side. Sampling locations are also presented on Figure 3-1. Sampling depths ranged from 2 inches to 8 inches.



SOURCE: WESTON DRAFT
OSC REPORT

LEGEND:

* SAMPLE LOCATIONS

--- SITE FENCE

- - - - DENOTES FLOODPLAIN



NOT TO SCALE

FIGURE 3-1
TAT SOIL SAMPLING
LOCATIONS
REPUBLIC STEEL QUARRY SITE

The samples collected from along the sides of the ditch were collected from a height of approximately 2.5 feet above the bottom of the ditch.

3.2.3 Composite Sample from Boat Launch and Pickle Liquor Discharge Ditch

In addition to the grab samples collected from both the pickle liquor discharge ditch and the boat launch area, aliquots from each grab sample location were collected and combined into a composite sample (S-85). This composite sample was divided evenly into four portions; one to be analyzed for disposal parameters and EP Toxicity metals, three to be analyzed by disposal facilities.

3.2.4 RI Derived Waste Drum Sampling

Seven drums on the north side of the quarry contained drill cuttings from installation of the monitoring wells during the Phase I RI. A composite sample (S-86), composed of material from each of the drums, was divided equally into four portions; one to be analyzed for disposal parameters and EP Toxicity metals, three to be analyzed by disposal facilities.

3.2.5 Analytical Results

The soil samples collected from the site were submitted to Grace Analytical Laboratories. The analytical results showed the presence of four PNA carcinogenic compounds targeted by the EPA for determining the extent of soil removal. These four target compounds were benzo(b)-fluoranthene, benzo(k)fluoranthene, chrysene, and benzo(a)anthracene. EPA established cleanup criteria for the soil removal specifying that if the sum of the four target compounds exceeded 300 parts per billion (ppb), removal would be required. Lab results from the soil samples for the four target compounds are summarized in Table 3-1. Soil samples from both the boat launch area and the pickle liquor discharge ditch were observed to exceed the established cleanup criteria. TAT attributed the elevated PNA concentrations found in background samples to fallout of coal products from the steel furnace and from vehicle exhaust.

The analyses for disposal parameters performed on the two composite samples, S-85 and S-86, did not indicate any characteristically hazardous materials and the analyses for EP Toxicity metals indicated concentrations below the maximum acceptable levels.

3.3 SOIL REMOVAL ACTIVITIES

On September 9, 1989, an Action Memorandum was submitted to the U.S. EPA Office of Superfund requesting funding for a removal action at the Republic Steel Quarry site. This was the first "removal" conducted in Region V, and combined the U.S. EPA remedial program funding with the Emergency and Enforcement Response Branch's contractor.

The Record of Decision (ROD) indicated that the removal of an estimated 100 cubic yards of contaminated soils would be required. This total included the contents of the seven drums located on the north side of quarry. TAT met with

TABLE 3-1
RESULTS OF TAT DISCRETE SAMPLES
FOR FOUR TARGET PNA COMPOUNDS
AUGUST 7-8, 1989

<u>Sample Number</u>	<u>Sample Location</u>	<u>Benzo(A) Anthracene</u>	<u>Chrysene</u>	<u>Benzo(B) Fluoranthene</u>	<u>Benzo(K) Fluoranthene</u>
S-66	Boat Ramp	BDL	BDL	BDL	BDL
S-67	Boat Ramp	BDL	BDL	BDL	BDL
S-68	Boat Ramp	BDL	BDL	BDL	BDL
S-69	Boat Ramp	BDL	BDL	BDL	BDL
S-70	Boat Ramp	BDL	BDL	BDL	BDL
S-71	Boat Ramp	BDL	55.9	BDL	BDL
S-72	Boat Ramp	BDL	BDL	BDL	BDL
S-73	Boat Ramp	81.6	122	112	114
S-74	Ditch	BDL	BDL	BDL	BDL
S-75	Ditch	480	799	1160	1040
S-76	Ditch	63.2	79.7	80.1	67.4
S-77	Ditch	62.8	74.4	88.8	56.6
S-78	Ditch	386	502	870	530
S-79	Background	924	924	1290	1270
S-80	Background	27.4	36.6	43.5	26.8
S-81	Ditch	36.0	42.2	53.3	35.3
S-82	Ditch	740	800	1000	1010
S-83	Ditch	148	193	257	128
S-84	Ditch	432	517	572	709

Concentrations in ug/kg

BDL = Below detection limit.

Sampling locations are presented on Figure 3-1.

the OSC and the ERCS contractor, MAECORP, on February 14, 1990, to begin the contaminated soil removal.

The RI estimated that bedrock was located 6-12 inches below the surface in the boat launch and pickle liquor discharge ditch areas because of the Berea sandstone outcrops that are adjacent to these areas. The Berea sandstone extends approximately ten feet above the boat launch and pickle liquor discharge ditch areas. TAT planned to remove the soil on top of the bedrock in both locations; however, upon commencing excavation activities TAT discovered that the bedrock was some distance greater than 1 foot below the ground surface. The bedrock was at greater depth due to quarrying operations that removed additional sandstone from the south end of the site. The upper one foot of soil was removed from both areas, to stay within the 100 cubic yard limit.

The soil excavation took 1.5 days to complete. Decontamination of the access roads generated more soil for disposal than was originally estimated. The extremely wet weather conditions during the excavation also increased the volume of soils removed. TAT demobilized the site until landfill approvals could be altered to a volume of 150 cubic yards.

Approvals were granted on March 9, 1990, and trucking arrangements were made. Additional roll-off boxes were ordered and decontamination of the access areas and equipment was completed. A decon pad was constructed and utilized in the decontamination of equipment. The decon water was collected and placed into 55-gallon drums. Arrangements for disposal of the water were negotiated through the City of Elyria's Publicly Operated Treatment Works (POTW). The soils were landfilled at Envirosafe Services in Oregon, Ohio, approximately 2 hours from the site.

Post-excavation sampling of the boat launch and drainage ditch areas was performed by TAT to ensure that the levels of contamination had been reduced to below the cleanup criteria. One composite sample was prepared from 8 aliquots in the boat launch area. A second composite sample was compiled from 8 aliquots in the ditch area. The same sample locations were used as shown in Figure 3-1. The samples were submitted to Grace Analytical Laboratories for BNA analysis. Results indicated that the composite sample collected from the drainage ditch contained the four targeted compounds in concentrations exceeding the 300 ppb action level. The results of the boat launch area indicated the removal in this area was successful. The analytical results of the March, 1990 sample for the four targeted compounds are presented in Table 3-2. Table 3-3 presents complete results from the BNA analysis.

Additional soil sampling was performed on April 27, 1990, to assess the vertical extent of soil contamination in the drainage ditch. TAT expected that a decreasing concentration gradient of PNAs would be seen as sampling progressed further from the surface. The April 27 sampling consisted of a composite, taken at a depth of one foot, from the same 8 locations as previously sampled in the drainage ditch (Figure 3-1). The sample was submitted to Analytical and Biological Laboratories for analysis. The analytical results for the four targeted compounds are presented on Table 3-2. The concentrations of the four targeted compounds were well below the

TABLE 3-2
RESULTS OF TAT COMPOSITE SAMPLES
FOR FOUR TARGET PNA COMPOUNDS

<u>Parameter</u>	<u>SAMPLE NUMBER AND DATE</u>			
	<u>S-60</u> <u>03/12/90</u>	<u>S-70</u> <u>03/12/90</u>	<u>S-07</u> <u>04/27/90</u>	<u>S-98</u> <u>06/15/90</u>
Benzo(a)anthracene	30.8 ppb	103 ppb	<10 ppb	23 ppb
Chrysene	38 ppb	171 ppb	<10 ppb	35 ppb
Benzo(b)fluoranthene	56.6 ppb	354 ppb	<10 ppb	<10 ppb
Benzo(k)fluoranthene	40 ppb	184 ppb	<10 ppb	<10 ppb

< indicated below detection limit.

NOTE: Sample S-60 is the "final" post-soil removal confirmation sample from the boat launch, sample S-70 is the initial confirmation sample from the pickle liquor discharge ditch following the first removal, sample S-07 was collected from one foot depth to evaluate the vertical distribution of the four target PNA compounds, and sample S-98 was the "final" post-soil removal confirmation sample from the pickle liquor discharge ditch.

TABLE 3-3

RESULTS OF TAT COMPOSITE SAMPLES
FOR COMPLETE BNA ANALYSES

SAMPLE NUMBER:	S-60	S-70	S-07 (1')	S-98
Phenol	20 U	20 U	300 U	11 U
bis(-2-Chloroethyl)Ether	15 U	15 U	300 U	11 U
2-Chlorophenol	20 U	20 U	300 U	11 U
1,3-Dichlorobenzene	20 U	20 U	300 U	11 U
1,4-Dichlorobenzene	20 U	20 U	300 U	11 U
Benzyl Alcohol	20 U	20 U	300 U	11 U
1,2-Dichlorobenzene	25 U	25 U	300 U	11 U
2-Methylphenol	10 U	10 U	300 U	11 U
bis(2-chloroisopropyl)Ether	25 U	25 U	300 U	11 U
4-Methylphenol	10 U	10 U	300 U	11 U
N-Nitroso-Di-n-Propylamine	15 U	15 U	300 U	11 U
Hexachloroethane	20 U	20 U	300 U	11 U
Nitrobenzene	25 U	25 U	300 U	11 U
Isophorone	25 U	25 U	300 U	11 U
2-Nitrophenol	20 U	20 U	300 U	11 U
2,4-Dimethylphenol	20 U	20 U	300 U	11 U
Benzoic Acid	30 U	30 U	300 U	56 U
bis(-2-Chloroethoxy)Methane	25 U	25 U	300 U	11 U
2,4-Dichlorophenol	20 U	20 U	300 U	11 U
1,2,4-Trichlorobenzene	20 U	20 U	300 U	11 U
Naphthalene	20 U	20 U	300 U	11 U
4-Chloroaniline	20 U	20 U	300 U	11 U
Hexachlorobutadiene	25 U	25 U	300 U	11 U
4-Chloro-3-Methylphenol	15 U	15 U	300 U	11 U
2-Methylnaphthalene	20 U	20 U	300 U	11 U
Hexachlorocyclopentadiene	20 U	20 U	300 U	11 U
2,4,6-Trichlorophenol	15 U	15 U	300 U	11 U
2,4,5-Trichlorophenol	15 U	15 U	300 U	56 U
2-Chloronaphthalene	15 U	15 U	300 U	11 U
2-Nitroaniline	20 U	20 U	300 U	56 U
Dimethyl Phthalate	15 U	15 U	300 U	11 U
Acenaphthylene	15 U	15 U	300 U	11 U
3-Nitroaniline	25 U	25 U	300 U	56 U

NOTES: All concentrations are presented in micrograms per kilogram, ug/kg.

U Indicates the compound was analyzed for but not detected. The value presented is the minimum attainable detection limit for the sample.

J Indicates an estimated value.

Sample S-60 is the "final" post-soil removal confirmation sample from the boat launch, sample S-70 is the initial confirmation sample from the pickle liquor discharge ditch following the first removal, sample S-07 was collected from one foot depth to evaluate the vertical distribution of the four target PNA compounds, and sample S-98 was the "final" post -soil removal confirmation sample from the pickle liquor discharge ditch.

TABLE 3-3 (Continued)

RESULTS OF TAT COMPOSITE SAMPLES
FOR COMPLETE BNA ANALYSES

SAMPLE NUMBER:	S-60	S-70	S-07 (1')	S-98
Acenaphthene	15 U	15 U	300 U	11 U
2,4-Dinitrophenol	15 U	15 U	300 U	56 U
4-Nitrophenol	15 U	15 U	300 U	56 U
Dibenzofuran	10 U	10 U	300 U	11 U
2,4-Dinitrotoluene	10 U	10 U	300 U	11 U
2,6-Dinitrotoluene	10 U	10 U	300 U	11 U
Diethylphthalate	10 U	10 U	300 U	11 U
4-Chlorophenyl-phenylether	10 U	10 U	300 U	11 U
Fluorene	10 U	10 U	300 U	11 U
4-Nitroaniline	30 U	30 U	300 U	56 U
4,6-Dinitro-2-Methylphenol	15 U	15 U	300 U	56 U
N-Nitrosodiphenylamine(1)	15 U	15 U	300 U	11 U
4-Bromophenyl-phenylether	15 U	15 U	300 U	11 U
Hexachlorobenzene	15 U	15 U	300 U	11 U
Pentachlorophenol	20 U	20 U	300 U	73
Phenanthrene	17.7	126	300 U	18
Anthracene	7.52 J	3	300 U	11 U
Di-n-Butylphthalate	20 U	20 U	300 U	11 U
Fluoranthene	29	170	300 U	63
Pyrene	34.8	162	300 U	33
Butylbenzylphthalate	343	113	300 U	11 U
Benzo(a)Anthracene	30.8	103	10 U	23
bis(2-Ethylhexyl)Phthalate	177	155	300 U	11 U
Chrysene	38	171	10 U	35
Di-n-Octyl Phthalate	37	39.9	300 U	11 U
Benzo(b)Fluoranthene	56.6	354	10 U	10 U
Benzo(k)Fluoranthene	40	184	10 U	10 U
Benzo(a)Pyrene	60.5	312	300 U	11 U
Indeno(1,2,3-cd)Pyrene	79.3	472	300 U	11 U
Dibenz(a,h)Anthracene	25.2	130	300 U	11 U
Benzo(g,h,i)Perylene	87.1	591	300 U	11 U

NOTES: All concentrations are presented in micrograms per kilogram, ug/kg.

U Indicates the compound was analyzed for but not detected. The value presented is the minimum attainable detection limit for the sample.

J Indicates an estimated value.

(1) Cannot be separated from diphenylamine.

Sample S-60 is the "final" post-soil removal confirmation sample from the boat launch, sample S-70 is the initial confirmation sample from the pickle liquor discharge ditch following the first removal, sample S-07 was collected from one foot depth to evaluate the vertical distribution of the four target PNA compounds, and sample S-98 was the "final" post -soil removal confirmation sample from the pickle liquor discharge ditch.

established 300 ppb action level. Table 3-3 presents complete results from the BNA analysis.

On June 13, 1990, TAT met with the OSC and MAECORP to resume excavation and removal of contaminated soils in the drainage ditch. The soil excavation took one day to complete. Soil was removed from the ditch to a depth of one foot. A total of approximately 40 cubic yards of soil was removed from the ditch and transported to EnviroSafe Services for landfilling. The City of Elyria allowed decontamination water to be disposed of through their POTW, via a combined sewer system.

Post-excavation sampling was performed at the same eight locations in the drainage ditch (Figure 3-1). The samples were submitted to ATEC Environmental Consultants for BNA analysis. Analytical results of this sampling indicated that the total concentration of the four targeted compounds was less than the 300 ppb cleanup criterion as shown on Table 3-2. Table 3-3 presents complete results from the BNA analysis.

3.4 CONCLUSIONS

The soil removal successfully reduced soil PNA concentrations in the boat launch and pickle liquor discharge ditch to levels below the established cleanup criterion. Low levels of PNAs and other semi-volatile organic compounds do still remain in the pickle liquor discharge ditch, and these compounds will be included in the revised endangerment assessment in Section 5.0 of this report.

4.0 GROUNDWATER RESAMPLING INVESTIGATION

4.1 INTRODUCTION

During the Phase I RI, two groundwater sampling efforts were conducted. The first groundwater sampling program involved sampling the eight wells and was performed during the week of August 17, 1987. Twelve groundwater samples consisting of eight well samples, a duplicate sample, a bottle blank, a bailer blank, and a sample of the water used by the drillers for coring and packer testing were collected and submitted for laboratory analyses.

A second groundwater sampling program was performed on March 14, 1988, to verify the presence of volatile organic compounds (methylene chloride and acetone) detected at Well B-1 during the first groundwater sampling program. It should be noted that acetone and methylene chloride are common laboratory contaminants. Four samples were collected, including a bottle blank, bailer blank, groundwater sample from monitoring well B-1 and a groundwater sample from well B-3. The second program did not detect acetone or methylene chloride in groundwater samples from the site.

EPA concluded that eliminating the August 1987 volatile organic data from the exposure assessment, based solely on March 1988 resampling data, was not conservative. Therefore, a third groundwater sampling program was conducted on October 5, 1988 to confirm or refute the presence of volatile organic compounds in groundwater downgradient from the site. The third groundwater sampling effort was necessary because the conflicting data on acetone and methylene chloride concentrations have significant impact on future use exposure scenarios involving groundwater ingestion.

4.2 GROUNDWATER RESAMPLING LOCATIONS AND METHOD

Table 4-1 presents the sample number, location, sampling date, pH, conductivity, and temperature of the groundwater samples. Groundwater resampling locations are shown on Figure 4-1.

Prior to sampling the wells, a minimum of five well volumes were purged from the well by hand bailing. Conductivity, pH, and temperature of the water were measured periodically during the purging. Conductivity, pH, and temperature, readings were taken at five minute intervals until three consecutive uniform values were obtained, indicating that the well had stabilized. Sampling of the wells was performed using decontaminated teflon bailers attached to nylon rope.

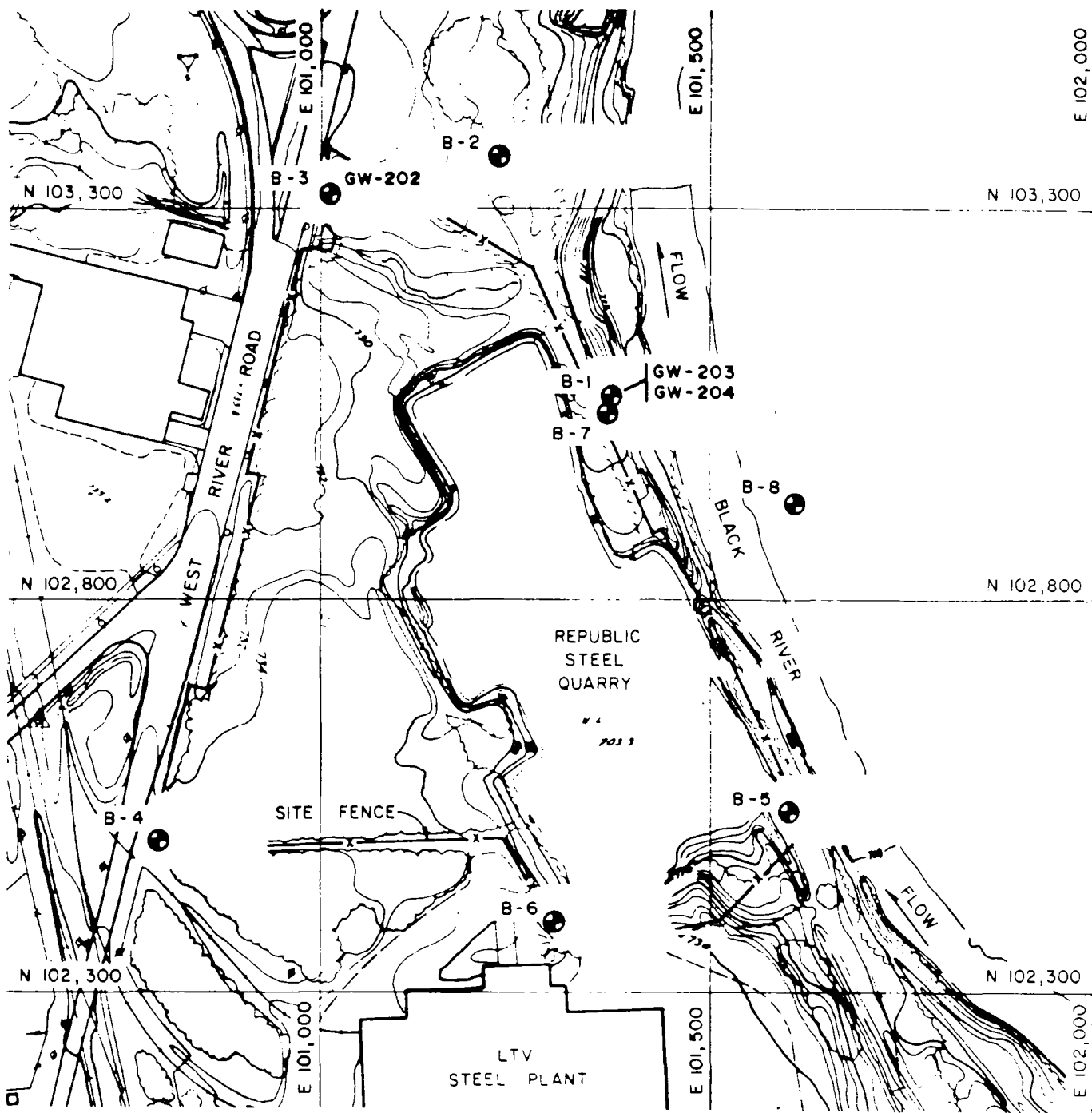
4.3 LABORATORY ANALYSES PERFORMED AND RESULTS

Laboratory analytical results are presented on Table 4-2. No significant Quality Assurance (QA) problems were identified during review of laboratory methods and results.

TABLE 4-1
GROUNDWATER SAMPLE DESCRIPTIONS

<u>Sample Number</u>	<u>Sample Location</u>	<u>Sampling Date</u>	<u>pH</u>	<u>Specific Conductance (umhos/cm.)</u>	<u>Temperature (°C)</u>
RSQ-GW-201	Bailer Blank	10/5/88	5.0	7	8.5
RSQ-GW-202	Well B-3	10/5/88	7.12	**	11.0
RSQ-GW-203	Well B-1	10/5/88	5.91	2100	10.0
RSQ-GW-204	Well B-1, Split	10/5/88	5.91	2100	10.0

** Conductivity meter not functioning properly.



SOURCE : CITY OF ELYRIA
ENGINEERING DEPARTMENT
SCALE: 1" = 100'

LEGEND:

B-3 ● GW-202 — GROUNDWATER SAMPLE NUMBER 202
FROM OCTOBER 1988 GROUNDWATER
SAMPLING PROGRAM

— MONITORING WELL B-3



0 200 400
SCALE IN FEET

FIGURE 4-1
GROUNDWATER RESAMPLING
LOCATIONS
REPUBLIC STEEL QUARRY SITE

TABLE 4-2
REPUBLIC STEEL QUARRY
GROUNDWATER RESAMPLING
VOLATILE ORGANIC ANALYSES

SAMPLE NUMBER:	GW201	GW202	GW203	GW204
SAMPLING DATE:	10/05/88	10/05/88	10/05/88	10/05/88
	BAILER	WELL B-3	WELL B-1	WELL B-1
SAMPLE LOCATION:	BLANK			SPLIT
Chloromethane	10 U	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U	10 U
Vinyl Chloride	10 U	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U	10 U
Methylene Chloride	13 U	14 U	12 U	10 U
Acetone	10 U	10 U	10 U	10 U
Carbon Disulfide	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5 U	5 U	5 U	5 U
1,2-Dichloroethene (total)	5 U	5 U	5 U	5 U
Chloroform	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5 U	5 U	5 U	5 U
2-Butanone	10 U	10 U	10 U	10 U
1,1,1-Trichloroethane	5 U	5 U	5 U	5 U
Carbon Tetrachloride	5 U	5 U	5 U	5 U
Vinyl Acetate	10 U	10 U	10 U	10 U
Bromodichloromethane	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U
Dibromochloromethane	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	5 U	5 U	5 U	5 U
Bromoform	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	10 U	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U	10 U
Tetrachloroethene	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U
Chlorobenzene	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U
Styrene	5 U	5 U	5 U	5 U
Total Xylenes	5 U	5 U	5 U	5 U

NOTES: All concentrations are presented in micrograms per liter, ug/l.
U Indicates the compound was analyzed for but not detected. The value presented is the minimum attainable detection limit for the sample.

4.4 NATURE AND EXTENT OF CONTAMINATION

Based on the March 1988 and October 1988 groundwater resampling efforts, both of which failed to detect volatile organic contaminants, groundwater at the Republic Steel Quarry site is estimated to be free of volatile organic contamination. The one downgradient monitoring well sample that detected acetone and methylene chloride during the August 1987 program is believed to have been due to laboratory or sampling procedure contamination. The revised endangerment assessment (EA) presented in Section 5.0 will therefore eliminate acetone and methylene chloride from the groundwater chemicals of concern.

4.5 CONCLUSIONS

Groundwater at the Republic Steel Quarry site does not contain volatile organic contamination. However, previous results of groundwater sampling performed during the Phase I RI indicate that the quarry is contributing to elevated levels of semi-volatile organic and inorganic chemicals in groundwater downgradient from the site. Semi-volatile organic and inorganic chemicals of concern identified in groundwater during the Phase I RI are included within the revised EA.

5.0 REVISED ENDANGERMENT ASSESSMENT

5.1 INTRODUCTION

The Republic Steel Quarry site is currently the subject of a CERCLA Supplemental Investigation being conducted by the REM IV team under contract to USEPA. The site is classified as an enforcement site, indicating the possibility of cost recovery measures against potentially responsible parties. In cases where enforcement actions may be taken under Section 106(a) of CERCLA, USEPA is required by the National Contingency Plan to undertake an Endangerment Assessment (EA) to properly document and justify its assertion that an imminent and substantial endangerment to public health, welfare, or the environment may exist. This endangerment assessment provides the information for any such justification. It is important to note at this juncture that "imminent" does not mean immediate harm; rather, it means an impending risk of harm. Sufficient justification for determination of an imminent endangerment may exist if harm is threatened; no actual injury need have occurred or be occurring. Similarly, "endangerment" means something less than actual harm (USEPA 1985).

This endangerment assessment addresses the potential human health and environmental impacts associated with the Republic Steel quarry site under the no-action alternative, that is, in the absence of remedial (corrective) action. Evaluation of the no-action alternative is required under Section 300.68(f)(v) of the National Contingency Plan.

The methodologies used in this EA are designed to be consistent with guidelines from the Office of Emergency and Remedial Response (Public Health Evaluation Manual 1986) and federal guidelines for risk assessment (EPA 1986).

It should be noted that this EA has been conducted using generally conservative assumptions according to the general guidelines outlined by USEPA. The purpose of using conservative assumptions is to explore the potential for adverse health effects using conditions that tend to overestimate risk so that the final estimates will usually be near or higher than the upper end of the range of actual exposures and risks. As a result, this risk assessment should not be construed as presenting an absolute estimate of risk to human or environmental populations. Rather, it is a conservative analysis intended to indicate the potential for adverse impact for Superfund sites in particular (EPA 1986).

The primary purpose of this revised EA was to incorporate recent sampling results. At the same time, current toxicity values and ARARs were also applied. As a result of using current toxicity values, some chemicals present a potential health risk in this EA that previously did not. (For example, beryllium was assigned a cancer potency factor since completion of the original EA and now constitutes a potential health risk under future-use groundwater ingestion scenarios. It should be noted that Elyria City water is available surrounding this site and it is highly unlikely that groundwater would be utilized as a source of drinking water by future residents.) This endangerment assessment has not been revised to conform to regulations and guidance which have been promulgated since the original endangerment assessment was completed. The reasons for continuing with the previous guidance procedures for the endangerment assessment are because: 1) the

revised EA methods and procedures will be consistent with the original EA which served to direct further investigation activities at this site; 2) budgetary constraints prohibited the performance of this EA using new guidance (because essentially an entirely new EA would have to be performed); and, 3) previous guidance generally utilizes more conservative assumptions for evaluating risks posed by the site, resulting in a more conservative assessment for protecting human health and the environment. In particular, the methodology and results in this EA do not reflect the National Contingency Plan promulgated in March 1990, EPA's Risk Assessment Guidance for Superfund, published in December 1989, and OSWER Directive 9850.4 on Interim Final Guidance for Soil Ingestion Rates. Additionally, EPA currently recommends using an integrated uptake/biokinetic model for assessment of exposure to lead at Superfund sites. Although a formal sensitivity analysis has not been prepared, it is likely that the risks reported in this document are higher than if they had been calculated using current guidance. This factor should be taken into account by risk managers in the process of decision making at the Republic Steel Quarry site.

This EA is organized as follows:

SECTION 5.2 SELECTION OF CHEMICALS OF CONCERN. In this section, the analytical data are reviewed to identify site-related chemicals.

The next four sections, 5.3, 5.4, 5.5, and 5.6 constitute the components of the human health risk assessment.

SECTION 5.3 TOXICITY CHARACTERIZATION. In this section, potential health effects associated with exposure to the chemicals of concern are discussed and the quantitative health criteria used in the EA are presented.

SECTION 5.4 HUMAN EXPOSURE ASSESSMENT. Potential pathways by which populations may be exposed under current or potential future land use conditions are evaluated. In addition, concentration of chemicals in environmental media at potential exposure points are identified for all complete pathways. Concentration estimates are derived using available concentration data, and/or chemical-specific physical and chemical properties, and models to describe the movement of chemicals in and between media.

SECTION 5.5 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS. In this section, concentrations of chemicals of concern in various exposure media are estimated. This is accomplished by using the RI data, the supplemental soil, groundwater and fish tissue data or by utilizing models to predict potential concentrations.

SECTION 5.6 HUMAN RISK CHARACTERIZATION. As one measure of risk, concentrations of site-related chemicals at exposure points are compared with applicable or relevant and appropriate requirements (ARARs). Since ARARs are not available for all chemicals in all media, quantitative risk estimates are also developed, where necessary, by combining the estimated intakes of potentially exposed populations (derived using conservative assumptions regarding exposure duration, route, frequency, and absorption of chemicals) with health effects criteria.

SECTION 5.7 ENVIRONMENTAL ASSESSMENT. In this section, potential impacts on aquatic life will be evaluated by comparison of surface water concentrations to available aquatic life criteria.

SECTION 5.8 UNCERTAINTIES. The uncertainties and limitations of this risk assessment are discussed.

SECTION 5.9 CONCLUSIONS. The main conclusions of the risk assessment are summarized.

This assessment is principally based on CERCLA Contract Laboratory Program data generated during the remedial investigation (RI) and Supplemental Investigation. Some assumptions have been made about site conditions (i.e., soil characteristics) where such data were not available. These assumptions and others derived from the USEPA Superfund Public Health Evaluation Manual (USEPA 1986) are referenced and documented as appropriate.

5.2 SELECTION OF CHEMICALS OF CONCERN

The earlier sections of the report have discussed the site background information and the results of the supplemental investigations that have taken place at the Republic Steel site. The results of sampling performed during the RI in August, 1987 and March, 1988 are summarized in this section to identify site related chemicals to be evaluated in this risk assessment. Additionally, groundwater, fish tissue and soil data collected during the Supplemental Investigation have been included to refine this assessment. Sampling results are discussed below by environmental media (soil, ground water, surface water, and sediments).

The following guidelines were used in evaluating data:

- o Data are summarized for each medium by presenting frequencies of detection, and ranges of detected values of each chemical.
- o Sample concentrations of certain inorganic chemicals in various media were compared with those levels considered to be naturally occurring in the region of the Republic Steel site in order to determine if the detected levels were elevated above 2 times the background concentration. The factor of 2 is chosen to compensate for the lack of a sufficient number of background samples to determine statistical significance and due to the highly variable nature of environmental sampling. The rationale for the selection of two times the background concentration as an evaluation criterion is presented in Appendix G of the RI report, Data Considerations. Table 5-1 presents available background data in soil and ground water. Although background samples were not available to compare sediment and surface water data from the quarry, they will be compared to concentrations of inorganic chemicals in off site sediment and surface water samples, since inorganics are naturally occurring constituents in these media.

TABLE 5-1
CONCENTRATIONS OF INORGANICS DETECTED AROUND THE REPUBLIC STEEL SITE

Chemical	Groundwater ^a (ug/l)	Soil ^b (mg/kg)
Aluminum	2,180	9,860
Antimony	254	
Arsenic	26	
Barium	38	66
Beryllium	0.5	
Cadmium	2	
Calcium	130,000	1,660
Chromium	7	9.6
Cobalt	4.5	11
Copper	11	31
Iron	2,450	20,900
Lead	2.5	32
Magnesium	63,300	1,990
Manganese	661	823
Mercury		
Nickel	14	15
Potassium	5,360	875
Selenium	25	
Silver	2	
Sodium	143,000	
Thallium	5	
Tin	119	
Vanadium	3.5	20
Zinc	13	84
Cyanide	5	

^a Groundwater samples collected from Wells B-3 and B-4

^b Soil samples SS-006 and SS-007

- o Surface water chemical concentrations will also be compared to chemical concentrations in background groundwater to eliminate chemicals from evaluation in the risk assessment. The quarry is below the groundwater level and is fed by groundwater. Therefore, this comparison is considered appropriate and will eliminate chemicals in surface water that are below 2 times the chemical concentrations detected in the background groundwater wells.
- o Concentrations reported for duplicate samples of a given sampling point were first averaged by calculating a geometric mean of the sample and its associated duplicate. If this geometric mean was below the sample detection limit, the sample was treated as a non-detect.
- o For chemicals detected in samples and blanks the common laboratory chemicals (i.e., acetone, methylene chloride, toluene, and phthalate esters) will be included as chemicals of concern when they are detected above 10 times the level detected in blanks. Carbon disulfide may also be considered a common laboratory contaminant and will be included as a chemical of concern when detected above 10 times the level detected in blanks. The remaining chemicals on the USEPA's target compound list will be included as chemicals of concern when they are detected above 5 times the level detected in blanks. This criterion is used much like data rejection in QA/QC data validation. For data validation purposes the laboratory rejects data when samples are less than 10 times the concentration observed in the QA/QC blank.
- o Data that were approximated (flagged with a J) by data validation, and data that were below the contract required detection limits were used in this assessment. For data below the detection limit (flagged with a U), half of the detection limit was used.
- o In evaluating risk, potentially carcinogenic polynuclear aromatic hydrocarbons (PNAs) are considered separately from noncarcinogenic PNAs. Therefore, data summary tables will list carcinogenic PNAs separately from noncarcinogenic PNAs. Details concerning this classification of PNAs are given in Section 5.5.
- o Phthalate esters may be considered contaminants in the samples at the Republic Steel site because certain samples have concentrations more than 10 times the blank samples. However, phthalate esters have been qualified in many instances indicating that the chemical was found in the laboratory blank as well as in the site related sample. Therefore, the possibility of these chemicals entering the sample in the laboratory is very real. If the contaminant enters a concentrated sample in the laboratory it will be multiplied by the dilution factor required by the experimental method. If the samples have a very high organic content, as is seen in sediment samples, this dilution can be substantial and the result may be a high reported concentration of phthalate esters. Though it is assumed that phthalate esters are present in the samples because of laboratory contamination, due to their very high concentrations, phthalate esters will be included in the assessment where they exceed 10 times the blank level.

Chemicals of concern are discussed below by medium.

5.2.1 Soil

Surface soils were analyzed at four areas of the site during the RI: the quarry discharge, the pickle liquor ditch, at the south boat launch, and at the southern end of the quarry near the steel plant yard. Near the steel plant yard slag material was being deposited onto the southern portion of the site from an off-site area of the steel plant yard. This is a good indication that the site will reflect the chemicals associated with the steel plant yard and not chemicals that are associated with the historic activity of the site. Nonetheless, the area is included in the site assessment. Background samples included a sample north of the site, and a sample west of the site. Additionally, a sample was obtained north of the site, next to the Black River. Table 5-1 lists concentrations of inorganic chemicals in background samples. Concentrations of chemicals in the sample obtained north of the site next to the Black River are listed in Table 5-2, adjacent to background samples, but the data were not used in comparison purposes for elimination of chemicals.

Table 5-2 lists the range of inorganic and volatile organic chemical concentrations detected in soil samples collected during the RI. The semi-volatile organic summary incorporates samples collected from two locations during the RI and two confirmation samples collected following removal actions. The RI samples used in this summary are SS-001 and its duplicate SS-008 collected near the discharge from the quarry to the Black River, and SS-004 which was collected from the south end of the quarry property near the LTV Steel plant yard. In addition, the confirmation sample from the ditch (following the second removal) is used in place of SS-002 from the RI, and the final confirmation sample from the boat launch area is used in place of sample SS-003 from the RI. Copper, chromium, manganese, calcium, iron and nickel were the inorganic chemicals observed at the site at more than 2 times the background concentrations near the site. Additionally, cadmium and mercury were not detected in the background samples and are considered to be elevated.

Toluene had concentrations in the samples at less than 10 times the background concentration, and will thus be removed from consideration. Acetone and methylene chloride are detected in soil at greater than 10 times concentrations detected in the laboratory blank, and will be treated conservatively as chemicals of concern. Additionally, 2-butanone will be selected as chemical of concern in soil. DDT was detected only in soil at one location of the site. Because of this low frequency of occurrence, and because DDT is not attributable to site activity, DDT will not be included as a chemical of concern. As mentioned, the semi-volatile organic data summary includes two RI samples and two post removal samples. Concentrations of polynuclear aromatic hydrocarbons (PNAs) have decreased in the boat launch area and the pickle liquor ditch following removal. However, PNAs are still present and they will be grouped as carcinogenic and noncarcinogenic and selected for further evaluation in this assessment. Additionally the phthalate esters detected in soil (bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, and butylbenzylphthalate) will be selected as chemicals of concern in soil. Pentachlorophenol and 2-methylnapthalene will not be selected for further evaluation because they were each only present in one sample at concentrations less than detected in the blank and background respectively.

TABLE 5-2

SURFACE SOIL DATA FROM AREAS AT AND NEAR THE REPUBLIC STEEL SITE

CHEMICAL	FREQUENCY OF DETECTION	NO. OF EST. VALUES	RANGE		BACKGROUND CONCENTRATIONS	BLANK CONCENTRATIONS	
			max	min			
VOLATILE ORGANIC ANALYSES (in ug/kg)							
Methylene chloride	2 /4	0	33	29			
Acetone	2 /4	0	150	130			
2-Butanone	1 /4	0	78	NR			
Toluene	1 /4	0	65	NR	95		
SEMIVOLATILE ORGANIC ANALYSES (in ug/kg)(a)							
Phenanthrene	3 /4	1	250	17.7	130	110*	39
Fluoranthene	3 /4	1	510	29	63	130*	
Pyrene	3 /4	1	330	33	60	160*	42
Benzo[a]anthracene	3 /4	1	260	23	70	110*	
bis(2-Ethylhexyl)phthalate	1 /4	0	177	NR			
Chrysene	3 /4	1	250	35	65	140*	
Di-n-octyl phthalate	1 /4	0	37	NR			58
Benzo[b]fluoranthene	1 /4	0	56.6	NR	76	260*	
Benzo[k]fluoranthene	1 /4	0	40	NR	76	260*	
2-methylnaphthalene	1 /4	0	11	NR	210		
Pentachlorophenol	1 /4	0	73	NR		100*	380
Anthracene	1 /4	0	7.52	NR			
Butylbenzylphthalate	1 /4	0	343	NR	49		
Benzy(a)pyrene	1 /4	0	60.5	NR			
Indeno(123-cd)pyrene	1 /4	0	79.3	NR			
Dibenzo(ah)anthracene	1 /4	0	25.2	NR			
Benzo(ghi)pyrene	1 /4	0	87.1	NR			

TABLE 5-2 (Continued)

SURFACE SOIL DATA FROM AREAS AT AND NEAR THE REPUBLIC STEEL SITE

CHEMICAL	FREQUENCY	NO. OF	RANGE		BACKGROUND CONCENTRATIONS		BLANK
	OF	EST.	-----				
	DETECTION	VALUES	max	min	-----	CONCENTRATIONS	
INORGANIC AND NON-ORGANIC SAS ANALYSES (in mg/kg)							
Aluminum	4 /4	0	3620	860	9860	3640*	9510
Barium	4 /4	0	94	70	66	42*	153
Cadmium	1 /4	0	4.5	NR			
Calcium	4 /4	0	16000	480	1660	2650*	12400
Chromium	4 /4	0	178	16	9.6	40*	13
Cobalt	2 /4	0	4	4	11	5*	13
Copper	4 /4	0	94	50	31	38*	41
Iron	4 /4	0	443000	24800	20900	85800*	21100
Magnesium	3 /4	0	3020	872	1990	1730*	3520
Manganese	4 /4	0	5990	116	823	903*	500
Mercury	2 /4	0	0.34	0.32			
Nickel	3 /4	0	73	15	15	34*	30
Potassium	4 /4	0	721	430	875	489*	1420
Vanadium	4 /4	0	32	6.7	20	12*	17
Zinc	4 /4	0	84	20	84	62*	135

PESTICIDE/PCBs AND SAS ORGANICS ANALYSES (in ug/kg)

4,4'-DDT	1 /4	0	419
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* Concentration from N. Black River downgradient. Not used in comparison purposes for elimination of chemicals.

NR = Not relevant, only detected in one sample and concentration is presented as maximum.

- (a) The semivolatile organic summary incorporates samples collected from 2 locations during the RI and 2 confirmation samples collected following removal actions. The RI samples used in this summary are SS-001 and its duplicate SS-008 collected near the discharge from the quarry to the Black River, and SS-004 which was collected from the south end of the quarry property near the LTV Steel plant yard. In addition, the confirmation sample from the ditch (following the second removal) is used in place of SS-002 from the RI, and the final confirmation sample from the boat launch area is used in place of sample SS-003 from the RI.

5.2.2 Sediment

Table 5-3 lists concentrations of inorganic and organic chemicals detected in quarry sediment samples.

Although methylene chloride and acetone are common laboratory contaminants, they will be considered as chemicals of concern because they were not detected in the blanks. Pentachlorophenol is observed at a very high level compared to the rest of the sampling at one location of the Republic Steel site. Pentachlorophenol is not thought to be associated with operations at the site and possible breakdown products of pentachlorophenol (i.e., 2-chlorophenol) were not observed at the site. However, due to the high concentration of pentachlorophenol detected from the one location, it will be considered as a chemical of concern.

Polynuclear Aromatic Hydrocarbons (PNAs) were observed at relatively high concentrations along with the solvents ethylbenzene, 2-butanone, and tetrachloroethene and have been included as chemicals of concern. PNAs were detected only in sediment samples and soil samples. These contaminants may be derived from cutting oils used in steel manufacturing as the PNA concentrations correspond to oil and grease concentrations in these sediments.

It should be noted that PNAs are ubiquitous in the environment, and background levels may be relatively high. PNAs are produced by virtually every combustion process, from forest fires to refuse burning. They are also released from internal combustion engine emissions. PNAs in soil result principally from the deposition of airborne PNAs. Based on data compiled from IARC (1973), White and Vanderslice (1980), and EPA (1982), total carcinogenic PNA concentrations in forest soils can range from 0.02 to 0.26 mg/kg. In urban soils, higher concentrations are found, with total carcinogenic PNA concentrations ranging from 100 to 175 mg/kg. This area of Ohio and specifically the Black River has a historical record of high ambient PNA levels due to the type and magnitude of industries such as steel plants and coking facilities (West et al. 1986; West et al. 1988). These high ambient concentrations could have an impact on the concentrations at the Republic Steel site. Because no data on background concentrations of this ubiquitous class of compounds are available for the Republic Steel site, PNAs are considered site-related and evaluated in this assessment.

The remaining organic chemicals detected in quarry sediment samples that have been selected as chemicals of concern are toluene and the phthalates. While no background concentration data is available for quarry sediments a comparison is made to inorganic concentrations in the upriver areas of the Black River. This comparison appears appropriate since inorganics are common constituents of even pristine soils and detectable concentrations of inorganics do not necessarily represent an anthropogenic source. Since the sampled areas of the Black River are close to the quarry we expect concentrations less than two times these comparison concentrations to represent ambient concentrations in the area and not to be attributable to the Republic Steel quarry site. Three inorganic chemicals, mercury, tin, and copper, were considered as chemicals of concern based on comparison to naturally occurring levels.

TABLE 5-3

QUARRY SEDIMENT DATA FROM THE REPUBLIC STEEL SITE

CHEMICAL	FREQUENCY OF DETECTION	NO. OF EST. VALUES	RANGE		COMPARISON CONCENTRATIONS	BLANK CONCENTRATIONS
			max	min		
VOLATILE ORGANIC ANALYSES (in ug/kg)						
Methylene chloride	2 /7	0	25	21		
Acetone	4 /7	4	1135	250		
Carbon disulfide	4 /7	0	27	1.6	53	73
2-Butanone	4 /7	4	360	65		
Tetrachloroethene	2 /7	0	38	18		
Toluene	4 /7	4	370	72		
Ethylbenzene	1 /7	1	28	NR		
SEMIVOLATILE ORGANIC ANALYSES (in ug/kg)						
Benzoic acid	1 /7	1	780	NR		280
Diethylphthalate	4 /7	0	56000	3700		46
Isophorone	1 /7	1	99	NR		43
Pentachlorophenol	2 /7	0	25000	7100		76
Phenanthrene	4 /7	3	12200	210	2400	41
Anthracene	2 /7	1	4000	72	590	
Di-n-butylphthalate	3 /7	0	31000	2400	330	
Fluoranthene	5 /7	4	17000	1200	3300	
Pyrene	4 /7	1	12200	310	2900	
Butylbenzylphthalate	2 /7	0	73000	36000	690	
Benzo[a]anthracene	3 /7	2	4450	210	4900	
bis(2-Ethylhexyl)phthalate	1 /7	0	68000	58000		
Chrysene	4 /7	3	4200	160	3400	
Di-n-octyl phthalate	3 /7	0	6250	2600		530
Benzo[b]fluoranthene	3 /7	1	6000	300	4800	
Benzo[k]fluoranthene	3 /7	1	6000	300	4800	
Benzo[a]pyrene	4 /7	3	4900	130	2400	
Indeno(1,2,3-cd)pyrene	2 /7	2	800	170	840	
Benzo[g,h,i]perylene	2 /7	2	700	190	750	
PESTICIDES/PCBs AND SAS ORGANICS ANALYSES (in ug/kg)						
Aroclor 1248	1 /7	0	1000	NR	3400	

TABLE 5-3 (Continued)

QUARRY SEDIMENT DATA FROM THE REPUBLIC STEEL SITE

CHEMICAL	FREQUENCY OF DETECTION	NO. OF EST. VALUES	RANGE		COMPARISON CONCENTRATIONS	BLANK CONCENTRATIONS
			max	min		
INORGANIC AND NON-ORGANIC SAS ANALYSES (in mg/kg)						
Aluminum	7 /7	0	17700	949	9340	16100
Arsenic	2 /7	0	42	40	31	12
Barium	7 /7	0	112	25	81	196
Beryllium	1 /7	0	2.3		1.8	1.7
Calcium	7 /7	3	73700	2440	59300	15100
Chromium	6 /7	0	64	9.7	63	28
Cobalt	1 /7	0	4.9		10	18
Copper	6 /7	0	300	18	72	61
Iron	7 /7	0	112000	19100	159000	39300
Lead	3 /7	0	100	14	202	24
Magnesium	7 /7	0	20300	699	18900	4930
Manganese	7 /7	0	1140	201	1450	628
Mercury	2 /7	0	0.73	0.45		
Nickel	6 /7	0	103	12	61	46
Potassium	6 /7	0	2290	477	940	2500
Tin	3 /7	0	108	10	18	
Vanadium	6 /7	0	29	8.1	22	37
Zinc	7 /7	0	369	80	261	190

NR: Not relevant, chemical was only detected in one sample and concentration is presented as maximum.

5.2.3 Surface water

Table 5-4 lists concentrations of inorganic and organic chemicals detected in surface water at the Republic Steel site at above the naturally occurring levels. For the inorganic chemicals, barium, calcium, iron, manganese, nickel, vanadium, and cadmium had concentrations above two times the comparison concentration. These inorganic chemicals will be considered chemicals of concern. Comparison to groundwater inorganic concentrations from background wells was used for comparison, as was comparison to area surface water inorganic concentrations.

No organic chemicals in the surface water were considered for the risk assessment. The pesticide lindane was detected at very low concentrations in one surface water area at the Republic Steel site and does not appear to be associated with the facility. Reported concentrations of lindane were below a level discernable by mass spectrometer techniques. Due to the uncertainty of the method used for lindane determination and the possibilities of laboratory contamination due to the very low concentrations detected, lindane was eliminated as a chemical of concern.

Aroclor 1254 was also detected in surface water, however, the sampling procedure used was to capture oil that emanated from disturbed sediments. The chemical was not detected in sediment samples. Thus, due to the bias of the sampling procedure and the low frequency of detection Aroclor 1254 was eliminated as a chemical of concern. The common laboratory contaminants detected in the samples below ten times laboratory blank concentrations will not be further evaluated.

5.2.4 Groundwater

Table 5-5 lists concentrations of inorganic and organic chemicals in groundwater detected at the Republic Steel site at above naturally occurring levels. Seventeen metals were detected at concentrations two times above the background concentrations. These were aluminum, beryllium, silver, vanadium, calcium, cadmium, cobalt, iron, manganese, potassium, chromium, copper, lead, zinc, nickel, barium, and sodium. These metals have been included as chemicals of concern.

Concentrations of pentachlorophenol, phenol, di-n-butylphthalate and bis(2-ethylhexyl)phthalate were detected very close to the detection limit. However, these organic contaminants have been conservatively included as chemicals of concern. Benzoic acid was detected at greater than 10 times blank concentrations and will be included as a chemical of concern. Groundwater samples collected during the RI had common laboratory contaminants below or near ten times the field blank concentrations except for acetone and methylene chloride which were detected in one well during the first sampling of the site. Methylene chloride and acetone were considered contaminants of concern during the EA performed in the RI report. However, methylene chloride and acetone were not identified as chemicals of concern in surface water, were only found in one downgradient monitoring well, and were not confirmed to be present during two subsequent sampling efforts. Therefore, acetone and

TABLE 5-4

QUARRY SURFACE WATER DATA FROM THE REPUBLIC STEEL SITE

CHEMICAL	FREQUENCY OF DETECTION	NO. OF EST. VALUES	RANGE		COMPARISON CONCENTRATIONS	BLANK CONCENTRATIONS
			max	min		
VOLATILE ORGANIC ANALYSES (in ug/L)						
Acetone	1 /17	0	27	NR		12
Toluene	3 /17	0	4.3	2		2.4
SEMIVOLATILE ORGANIC ANALYSES (in ug/L)						
Bis(2-ethylhexyl)phthalate	3 /17	0	14	3		
PESTICIDE/PCBs AND SAS ORGANIC ANALYSES (in ug/L)						
Lindane	2 /35	0	0.09	0.08		
Aroclor 1254	1 /35	0	2.9	NR		
INORGANIC AND NON-ORGANIC SAS ANALYSES (in ug/L)						
Aluminum	13 /20	0	808	33	1040 /2180	30
Arsenic	1 /20	0	8.7	NR	/26	
Barium	20 /20	0	113	21	43 /38	
Cadmium	1 /20	0	12	NR	/2	
Calcium	20 /20	0	315000	63700	71100 /130,000	672
Copper	6 /20	0	14	5.9	8.8 /11	14
Iron	20 /20	0	1600000	57	1630 /2450	94
Lead	3 /20	0	19	3.9	19 /	8.2
Magnesium	20 /20	0	88900	16800	19800 /63300	213
Manganese	20 /20	0	25700	28	88 /661	
Nickel	5 /20	0	86	9.4	8.3 /14	
Potassium	20 /20	0	8050	4070	5960 /5360	
Sodium	20 /20	0	49200	37300	24900 /143,000	956
Vanadium	7 /20	0	60	6.8	4.9 /3.5	
Zinc	13 /20	0	37	3.5	15 /13	12

NR = not relevant, chemical was only detected in one sample and concentration is presented as maximum.

TABLE 5-5

GROUNDWATER DATA SUMMARY FROM WELLS AT AND NEAR THE REPUBLIC STEEL QUARRY

CHEMICAL	FREQUENCY OF DETECTION	NO. OF EST. VALUES	RANGE		COMPARISON CONCENTRATIONS	BLANK CONCENTRATIONS
			max	min		
VOLATILE ORGANIC ANALYSES (in ug/L)						
Methylene chloride(a)	3 /9		140	3	11	8
Acetone(a)	1 /9		55	NR		
Chloroform(a)	1 /9		9	NR	74	
Toluene(a)	4 /9	4	4	1	2	3
SEMIVOLATILE ORGANIC ANALYSES (in ug/L)						
Phenol	1 /6		10	NR		
Benzoic acid	1 /6	1	42	NR		
Pentachlorophenol	1 /6	1	5	NR		
Di-n-butylphthalate	1 /6	1	3.9	NR		
bis(2-Ethylhexyl)phthalate	2 /6		11	7.1		
INORGANIC AND NON-ORGANIC SAS ANALYSES (in ug/L)						
Aluminum	6 /6		11600	94	2180	18
Arsenic	2 /6		21	13	26	
Barium	6 /6		114	20	38	
Beryllium	3 /6		2.1	1	0.5	
Cadmium	4 /6		6.4	2.8	2	
Calcium	6 /6		470,000	69700	130000	
Chromium	3 /6		20	8.5	7	
Cobalt	3 /6		18	9.4	4.5	
Copper	3 /6		28	6.5	11	
Iron	6 /6		571000	283	2450	45
Lead	1 /6		19	NR	2.5	
Magnesium	6 /6		88000	16900	63300	
Manganese	6 /6		11600	145	661	
Nickel	4 /6		131	24	14	
Potassium	6 /6		37200	3250	5360	
Silver	1 /6		4.1	NR	2	
Sodium	6 /6		324000	29700	143000	
Tin	2 /6		73	NR	119	119
Vanadium	4 /6		57	8.7	3.5	
Zinc	6 /6		106	7.7	13	

(a) Not detected during the two most recent sampling events.

NR = Not relevant, chemical was only detected in one sample and concentration is presented as maximum.

methylene chloride will not be included as chemicals of concern for this endangerment assessment.

5.2.5 Summary

The chemicals presented in Table 5-6 were present in one or more media at the Republic Steel site above levels considered to be naturally occurring and are therefore included in this EA. Carcinogenic and noncarcinogenic PNAs detected in soil and sediments at this site are presented in Table 5-7.

5.3 TOXICITY CHARACTERIZATION

The general methodology for the classification of health effects and the development of health effects criteria is described in Section 5.3.1 in order to provide the analytical framework for the characterization of human health impacts in Section 5.5. In section 5.3.2, the concept of chemical-specific ARARs is introduced, and the types of standards, criteria, or guidance that may be classified as potential ARARs for the Republic Steel site are described. In addition, potential ARARs and the numerical values of health effects criteria that will be used in the quantitative risk assessment are presented in tabular form.

5.3.1 Health Effects Classification and Criteria Development

For risk assessment purposes, individual pollutants are separated into two categories of chemical toxicity depending on whether they exhibit noncarcinogenic or carcinogenic effects. This distinction relates to the currently held scientific opinion that the mechanism of action for each category is different. EPA has adopted, for the purpose of assessing risks associated with potential carcinogens, the scientific position that a small number of molecular events can cause changes in a single cell or a small number of cells that can lead to tumor formation. This is described as a no-threshold mechanism, since there is essentially no level of exposure (i.e., a threshold) to a carcinogen which will not result in some finite possibility of causing the disease. In the case of chemicals exhibiting noncarcinogenic effects, however, it is believed that organisms have protective mechanisms that must be overcome before the toxic endpoint is manifested. For example, if a large number of cells performs the same or similar functions, it would be necessary for significant damage or depletion of these cells to occur before an effect could be seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without appreciable risk of causing the disease (EPA 1987).

5.3.1.1 Health Effects Criteria for Noncarcinogens

Health criteria for chemicals exhibiting noncarcinogenic effects are generally developed using risk reference doses (RfDs) developed by the USEPA RfD Work Group, or RfDs obtained from Health Effects Assessments (HEAs). The RfD, expressed in units of mg/kg/day, is an estimate of the daily exposure to the human population (including sensitive subpopulations) that is likely to be without an appreciable risk of deleterious effects during a lifetime. These RfDs are usually derived either from human studies involving workplace

TABLE 5-6
CHEMICALS OF CONCERN SELECTED AT THE REPUBLIC STEEL SITE

Medium	Chemical	
Groundwater	ALUMINUM BARIUM BENZOIC ACID BERYLLIUM CALCIUM CHROMIUM COBALT COPPER IRON LEAD	NICKEL PENTACHLOROPHENOL PHENOL POTASSIUM SILVER VANADIUM ZINC MANGANESE SODIUM CADMIUM BIS(2-ETHYLHEXYL) PHTHALATE DI-N-BUTYL PHTHALATE
Surface Water	BARIUM CALCIUM IRON MANGANESE	NICKEL VANADIUM CADMIUM
Sediment	ACETONE 2-BUTANONE COPPER ETHYLBENZENE MERCURY METHYLENE CHLORIDE PENTACHLOROPHENOL ncPNA ^a cPNA ^b BIS(2-ETHYLHEXYL) PHTHALATE	BUTYLBENZYL PHTHALATE DIETHYL PHTHALATE DI-N-BUTYL PHTHALATE DI-N-OCTYL PHTHALATE TIN TETRACHLOROETHENE TOLUENE
Soil	2-BUTANONE CHROMIUM COPPER MANGANESE MERCURY METHYLENE CHLORIDE ncPNA ^a ACETONE	cPNA ^b BIS(2-ETHYLHEXYL) PHTHALATE DI-N-BUTYL PHTHALATE DI-N-OCTYL PHTHALATE CALCIUM IRON NICKEL CADMIUM

^a = non-carcinogenic by IARC 1983 criteria

^b = carcinogenic by IARC 1983 criteria

TABLE 5-7
IDENTIFICATION OF NON-CARCINOGENIC PNAs AND CARCINOGENIC PNAs
AT THE REPUBLIC STEEL SITE

Sediment:	nc PNA ^a :	Phenanthrene Fluoranthene Pyrene Anthracene Benzo(g,h,i)perylene
	c PNA ^b :	Benzo[b]fluoranthene Benzo[k]fluoranthene Benzo[a]pyrene Indeno(1,2,3-cd)pyrene Benzo(a)anthracene
Soil:	nc PNA ^a :	Fluoranthene Pyrene Phenanthrene Anthracene Benzo(g,h,i)perylene
	c PNA ^b :	Benzo[a]anthracene Chrysene Benzo[b]fluoranthene Benzo[k]fluoranthene Benzo(a)pyrene Indeno (1,2,3-cd) pyrene Dibenzo (a,h)anthracene

^a = non-carcinogenic by IARC 1983 criteria.

^b = carcinogenic by IARC 1983 criteria.

exposures or from animal studies, and are adjusted using uncertainty factors. It should be noted that there are no RfDs which have been developed specifically for the dermal exposure pathways and as a result, oral RfDs have been used in this assessment. These RfDs are based on administered oral doses, not absorbed doses. The RfD provides a benchmark to which chemical intakes by other routes (e.g., via exposure to contaminated environmental media) may be compared.

5.3.1.2 Health Effects Criteria for Potential Carcinogens

Cancer potency factors, developed by EPA's Carcinogen Assessment Group (CAG) for potentially carcinogenic chemicals and expressed in units of $(\text{mg/kg/day})^{-1}$, are derived from the results of human epidemiological studies or chronic animal bioassays. The animal studies must usually be conducted using relatively high doses in order to detect possible adverse effects. Since humans are expected to be exposed at lower doses than those used in the animal studies, the data are adjusted by using mathematical models. The data from animal studies are fitted to the linearized multistage model to obtain a dose-response curve. The 95th percentile upper confidence limit slope of the dose-response curve is subjected to various adjustments and an interspecies scaling factor is applied to derive the cancer potency factor for humans. Thus, the actual risks associated with exposure to a potential carcinogen quantitatively evaluated based on animal data are not likely to exceed the risks estimated using these cancer potency factors, but they may be much lower. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad hoc basis. These models provide rough, but plausible, estimates of the upper limits on lifetime risk. Cancer potency factors based on human epidemiological data are also derived using very conservative assumptions and, as such, they too are unlikely to underestimate risks. Therefore, while the actual risks associated with exposures to potential carcinogens are unlikely to be higher than the risks calculated using a cancer potency factor, they could be considerably lower.

EPA assigns weight-of-evidence classifications to potential carcinogens. Under this system, chemicals are classified as either Group A, Group B1, Group B2, Group C, Group D, or Group E. Group A chemicals (human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer. Groups B1 and B2 chemicals (probable human carcinogens) are agents for which there is limited (B1) or inadequate (B2) evidence of carcinogenicity from human studies but for which there is sufficient evidence of carcinogenicity from animal studies. Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals, and Group D chemicals (not classified as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available. Group E chemicals (evidence on non-carcinogenicity in humans) are agents for which there is no evidence of carcinogenicity in adequate human or animal studies.

5.3.2 Applicable or Relevant and Appropriate Requirements (ARARs)

The Superfund Amendments and Reauthorization Act (SARA) and concurrent EPA interpretation provide guidance on selecting health-based applicable or relevant and appropriate requirements (ARARs) (EPA 1987) to be met at

Superfund sites. ARARs are selected by EPA on a site-by-site basis taking into consideration such factors as groundwater classification. Potential ARARs are defined below and may include drinking water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), Federal Ambient Water Quality Criteria, National Ambient Air Quality Standards (NAAQS), and state environmental standards.

The USEPA's interim guidance on ARARs (EPA 1987) defines ARARs as follows:

Applicable Requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

Relevant and appropriate requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Only those ARARs or advisories or guidance that are ambient or chemical-specific requirements (i.e., those requirements which "set health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants" (EPA 1987b) as opposed to ARARs which are classified as action-specific or locational requirements) are used in risk assessment. The classes of ambient or chemical-specific ARARs or guidance which are considered pertinent to the risk assessment for the Republic Steel site are discussed below by environmental medium.

5.3.2.1 Surface Water

State Water Quality Standards. States may promulgate their own water quality standards, either by adopting Federal water quality standards or by setting criteria which are more restrictive than the Federal standards. The State of Ohio has revised its Water Quality Standards effective May 1, 1990. The aquatic life habitat for the Black River near the Republic Steel Quarry is identified as warmwater and seasonal salmonid based on the results of a biological field assessment performed by the OEPA. Ohio State ARARs for the chemicals of concern are listed in Table 5-8.

Federal Water Quality Standards. Federal Water Quality Standards are available for fish consumption and for acute and chronic toxicity of aquatic life. Of the 35 chemicals of potential concern in water and sediment at the Republic Steel Site, 12 have available criteria for consumption of fish and 22 have available criteria for acute and/or chronic toxicity. These criteria are available along with State of Ohio Criteria in Table 5-8.

TABLE 5-8
SURFACE WATER QUALITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN
AT THE REPUBLIC STEEL SITE

Chemical	Ohio State ARARS Aquatic Life (ug/L)	Federal Water Quality Criteria ug/L Consumption of Fish	Federal Water Quality Criteria (ug/L) Aquatic Life	
			Acute	Chronic
ncPNA	--	--	2,300 ^a	620 ^a
cPNA ^f	--	0(0.031 ^e)	--	--
Pentachlorophenol	8.7 ⁱ	--	20 ^c	13 ^c
Diethylphthalate	--	1,800,000	940 ^{ad}	3 ^{ad}
Acetone	550,000 ^b	--	--	--
Tetrachloroethene	540 ^b	0(8.85) ^e	5,280	840
Ethylbenzene	1,400 ^b	3,280	32,000 ^a	--
2-Butanone	160,000 ^b	--	--	--
Di-n-butylphthalate	350 ^b	154,000	940 ^{ad}	3 ^{ad}
bis(2-ethylhexyl) phthalate	1,100 ^b	50,000	940 ^{ad}	3 ^{ad}
Iron	--	--	--	1,000
Nickel	1,600 ^{gh}	100	1,400 ^g	160 ^g
Vanadium	--	--	--	--
Tin	--	--	--	--
Calcium	--	--	--	--
Copper	18 ^{gh}	--	18 ^g	12 ^g
Mercury	1.1 ^b	0.146	2.4	0.012
Barium	--	--	--	--
Manganese	--	100 ^g	--	--
Methylene Chloride	9,700 ^b	--	--	--
Butylbenzylphthalate	230 ^b	--	940 ^{ad}	3 ^{ad}
Di-n-octylphthalate	--	--	940 ^{ad}	3 ^{ad}
Toluene	2,400 ^b	424,000	17,500	--

^a Insufficient data to develop criteria. Value presented is L.O.E.L. - Lowest Observed Effect Level. These are not promulgated standards; presented for information purposes only.

^b Maximum outside mixing zone for warmwater and seasonal salmonid habitats.

^c pH dependent criteria (7.8 pH used).

^d Criteria for phthalate esters.

^e Human health criteria for carcinogens reported for the risk levels. Value presented in parenthesis is the 10⁻⁶ risk level.

^f cPNA considered as benzo(a)pyrene.

^g Hardness dependent criteria (100 mg/l) used.

^h Outside mixing zone maximum criteria.

ⁱ Outside mixing zone maximum criteria: pH of 7.0.

TABLE 5-8 (Continued)
SURFACE WATER QUALITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN
AT THE REPUBLIC STEEL SITE

Chemical	Ohio State ARARs Aquatic Life (ug/L)	Federal Water Quality Criteria ug/L Consumption of Fish	Federal Water Quality Criteria (ug/L) Aquatic Life	
			Acute	Chronic
Aluminum	--	--	750	--
Beryllium	520 ^{gh}	0.(0.117) ^e	130 ^a	5.3 ^a
Chromium	1,800 ^{gh}	--	16 ^j	11 ^j
Cobalt	--	--	--	--
Lead	130 ^{gh}	--	8.2 ^g	3.2 ^g
Potassium	--	--	--	--
Silver	1.6 ^{gh}	--	4.1 ^g	0.12
Zinc	120 ^{gh}	--	120 ^g	110 ^g
Sodium	--	--	--	--
Cadmium	5.6 ^{gh}	--	3.9 ^g	1.1 ^g
Benzoic Acid	--	--	--	--
Phenol	5,000 ^b	--	10,200 ^a	2,560 ^a

^a Insufficient data to develop criteria. Value presented is L.O.E.L. - Lowest Observed Effect Level. These are not promulgated standards; presented for information purposes only.

^b Maximum outside mixing zone for warmwater and seasonal salinoid habitats.

^c pH dependent criteria (7.8 pH used).

^d Criteria for phthalate esters.

^e Human health criteria for carcinogens reported for the risk levels. Value presented in parenthesis is the 10⁻⁶ risk level.

^f cPNA considered as benzo(a)pyrene

^g Hardness dependent criteria (100 mg/l) used.

^h Outside mixing zone maximum criteria.

ⁱ Outside mixing zone maximum criteria: pH of 7.0.

^j Based on Chromium VI

5.3.2.2 Groundwater

Primary and Secondary Maximum Contaminant Limits (MCLs and SMCLs). Primary MCLs are Federal drinking water standards promulgated under the Safe Drinking Water Act (SDWA). Generally an MCL for a toxic chemical represents the allowable lifetime exposure to the contaminant for a 70-kg adult who is assumed to ingest two liters of water per day. In addition to health factors, an MCL is required by law to reflect the technological and economic feasibility of removing the contaminant from the water supply. The limit set must be feasible given the best available technology and treatment techniques (EPA 1986).

Secondary MCLs are Federal standards promulgated under the SDWA to control contaminants that primarily affect the aesthetic qualities (such as taste and odor) that would relate to the public acceptance of drinking water. Secondary MCLs are not federally enforceable standards (40 CFR 143).

According to EPA guidance on the use of MCLs as ARARs (EPA 1987), MCLs are applicable at the tap where the water will be provided directly to 25 or more people or will be supplied to 15 or more service connections, but in addition are relevant and appropriate requirements against which to evaluate groundwater quality.

Maximum Contaminant Level Goals (MCLG). MCLGs are promulgated under the SDWA as chemical-specific health criteria used in setting MCLs and other enforceable drinking water standards. An MCLG for a toxic chemical is based only on health considerations (i.e., technological and economic considerations are not included) and represents a level at which no adverse effects occur (EPA 1987). Since MCLs are set as close to MCLGs as possible, EPA does not consider MCLGs to represent a separate class of ARARs.

Drinking water ARARs are available for 15 of the 22 chemicals of concern in groundwater at the Republic Steel site. These ARARs are presented along with Ohio State ARARs for Public Water Supply in Table 5-9.

5.3.2.3 Soil and Sediment

No Federal or State standards, criteria or guidelines have been identified for chemicals in soil or sediment.

5.3.2.4 Numerical Values of ARARs and Toxicity Criteria

Tables 5-8 and 5-9 presents the numerical values of ARARs and other guidance identified for site-related chemicals of concern in surface water, sediment and groundwater at the Republic Steel site. Health effects criteria values for all chemicals of concern are presented in Table 5-10. It should be noted that health criteria appropriate for use in a quantitative risk assessment have not been developed for some of the selected chemicals of concern; therefore, they are not listed in Table 5-10. Among this group of chemicals, calcium, cobalt, iron, sodium, and potassium are not especially toxic following oral exposure and are essential human nutrients. Concentrations of these chemicals will be compared to ARARs but they will not be addressed in the quantitative risk characterization. In addition, concentrations of aluminum will only be compared to ARARs since it has a low acute toxicity

TABLE 5-9
DRINKING WATER ARARs FOR CHEMICALS OF POTENTIAL CONCERN
AT THE REPUBLIC STEEL SITE

Chemical	Ohio State Public Water Supply (ug/L)	Federal (ug/L)
Pentachlorophenol	1,000 ^c	200 MCLG
Phenol	1 ^{bc}	3,500 WQC ^a
Benzoic Acid	--	--
Chromium	50 ^c	50 MCL
Copper	1,000 ^c	--
Lead	50 ^c	50 MCL
Nickel	610 ^c	15.4 WQC
Zinc	5,000 ^c	5,000 WQC ^{ab}
Silver	50 ^c	50 WQC ^a
Aluminum	--	--
Barium	1,000 ^c	1,000 MCL
Beryllium	0.068 ^c	0 (3.9 ng/l)
Calcium	--	--
Cobalt	--	--
Iron	300 ^c	300 MCL ^b
Manganese	50 ^c	--
Potassium	--	--
Vanadium	--	--
Sodium	--	--
Cadmium	10 ^c	10 MCL
Bis(2-ethylhexyl) phthalate	18 ^c	21,000 WQC ^a
di-n-Butylphthalate	2,700 ^c	44,000 WQC ^a

^a Insufficient data to develop criteria. Value presented is L.O.E.L. - Lowest Observed Effect Level. These are not promulgated standards; presented for information purposes only.

^b Maximum outside mixing zone for warmwater and seasonal salmonid habitats.

^c Human health 30-day average.

TABLE 5-10
TOXICITY CRITERIA FOR SITE-RELATED CHEMICALS OF CONCERN
AT THE REPUBLIC STEEL SITE

Chemical	Reference Dose (RfD)		Carcinogenic Potency Factor Oral	Weight of Evidence
	Oral (mg/kg/day)	Source		
Acetone	1.0E-01	IRIS	--	--
Barium	5.0E-02	IRIS	--	--
Benzoic acid	4.0E+00	IRIS	--	--
Beryllium	5.0E-03	IRIS	4.3	B2
Bis(2-ethylhexyl)phthalate	2.0E-02	IRIS	1.4E-02	B2
2-Butanone (MEK)	5.0E-02	IRIS	--	--
Butylbenzylphthalate	2.0E-01	IRIS	--	--
Cadmium	5.0E-04	IRIS	--	--
	1.0E-03	water food		
Chromium	5.0E-03	HEA (a)	--	--
Copper	3.7E-02	HEA	--	--
cPNA	--	--	11.5 (b)	B2
Diethylphthalate	8.0E-01	IRIS	--	--
Di-n-butylphthalate	1.0E-01	IRIS	--	--
Ethylbenzene	1.0E-01	IRIS	--	--
Manganese	2.2E-01	HEA	--	--
Mercury (inorganic)	3.0E-04	--	--	--
Methylene chloride	6.0E-02	IRIS	7.5E-3	B2
ncPNA	4.0E-03	HEA (c)	--	--
Nickel	2.0E-02	IRIS	--	--
Pentachlorophenol	3.0E-02	IRIS	--	--
Phenol	6.0E-01	IRIS	--	--
Silver	3.0E-03	IRIS	--	--
Tetrachloroethene	1.0E-02	IRIS	5.1E-02	B2
Tin	6.4E-01	HEA	--	--
Toluene	3.0E-01	IRIS	--	--
Vanadium	7.0E-03	HEA	--	--
Zinc	2.1E-01	HEA	--	--

HEA = Health Effects Assessment
IRIS = Integrated Risk Information System

- (a) Based on chromium (VI).
(b) Based on potency of benzo[a]pyrene. This potency factor is being reevaluated by EPA; nevertheless, it will be used in EA for quantitative assessment.
(c) Based on toxicity of naphthalene.

following oral exposure, and there are inadequate dose-response data from which to estimate an acceptable daily intake level for ionic aluminum in drinking water (EPA 1985). Detailed information on the toxicity of the chemicals of concern was provided in the Toxicity Profiles (Appendix N of the RI report). However, for some chemicals, toxicity criteria have changed since the EA was written. These chemicals and a summary of recent toxicological information supporting changes in criteria are presented in Appendix A of this Supplemental Report.

5.4 POTENTIALLY EXPOSED POPULATIONS AND EXPOSURE PATHWAYS

An exposure pathway (the link between the source and the receptors) is defined by the following four elements:

- o A source and mechanism of chemical release to the environment;
- o An environmental transport medium for the released chemical;
- o A point of potential exposure by the receptor with the medium; and
- o A route of exposure (i.e., inhalation, ingestion, dermal contact).

An exposure pathway is considered "complete" if all these elements are present. The first two elements of an exposure pathway, a source and transport of a chemical have been addressed to some extent above and fully in previous sections of this report. This subsection addresses the last two elements and identifies populations exposed to site-related contaminants onsite under current and possible future land-use conditions and also identifies the routes through which these populations may be exposed.

5.4.1 Site and Surrounding Area Under Current-Use Conditions

The Republic Steel Quarry is located in an area of mixed industrial, commercial and residential land use. The quarry occupies approximately 4 acres. Although the quarry is fenced, it is accessible through a large hole in the fence. There is known to be some use of the site by local populations.

During the period of data collection for the RI, children were observed swimming in the quarry on several occasions and numerous incidents of vandalism occurred.

Taking into account the above factors, potential pathways of exposure to contaminants at the Republic Steel Quarry site under current land-use conditions have been identified and are discussed below by exposure medium (soil, air, groundwater, surface water and sediment). These potential exposure pathways also are summarized in Table 5-11 along with an indication of whether the pathway is complete.

Exposures to Soil. Under current conditions at the site, trespassers on the site may potentially come into dermal contact with contaminants. However, almost all of the area surrounding the quarry is heavily vegetated, limiting areas for exposure to occur. The area of the south boat launch as well as a

TABLE 5-11
POTENTIAL PATHWAYS OF EXPOSURE TO CONTAMINANTS ORIGINATING AT THE REPUBLIC STEEL QUARRY
UNDER CURRENT-USE CONDITIONS

Medium	Potential Routes of Exposure	Potential Receptors	Pathway Complete?
Soil (surface)	Dermal absorption, incidental ingestion	Trespassers	Yes. However, the majority of the site is densely vegetated.
Air	Inhalation of volatile organics and/or fugitive dust	Trespassers, nearby residents	No. Dense vegetation cover prohibits soils from becoming airborne.
Surface water/ Sediment	Dermal absorption, incidental ingestion	Trespassers swimming in quarry	Yes. Trespassers have been observed swimming in the quarry. Quarry depth precludes exposure to sediment.
	Uptake by fish with subsequent ingestion by humans	Trespassers fishing in quarry People fishing in nearby surface water bodies.	Yes. Large fish were observed in the quarry. No. No site related contaminants have been detected in Black River downgradient of the quarry.
Groundwater	Ingestion, inhalation, dermal absorption	Local residents	No. Groundwater is not currently being used for a potable supply in the vicinity of the site.

steep area where slag material is sliding onto quarry property from the adjacent steel plant yard are the two areas where contact of individuals with surface soil is most likely to occur. Therefore, direct contact with soils associated with dermal absorption and incidental ingestion of contaminants in surface soils by trespassers is considered to be a complete exposure pathway. No samples were collected from subsurface soils at the site; there are currently no ways in which subsurface soils are likely to be contacted although they may act as sources of contaminants to groundwater.

Exposures to Air. Site trespassers potentially could be exposed to contaminants present in the air through inhalation of volatile organics and/or fugitive dust emitted from soils or surface waters. As discussed above, most areas of the site surrounding the quarry are heavily vegetated, making the generation of dust by wind erosion highly unlikely. In addition, because the volatile chemicals detected in soils and quarry water were generally present at very low concentrations, the likelihood of significant vapors being generated is low. Therefore, exposures of trespassers or downwind receptors to site contaminants through inhalation of volatile chemicals or fugitive dust are not considered likely to be significant under current-use conditions of the site, and will not be evaluated as a current exposure pathway.

Exposures to Surface Water/Sediment. Site trespassers potentially may be exposed to surface water or sediments on the site while swimming in the quarry. As mentioned previously, children were observed swimming in the quarry on several occasions during RI field work. Therefore, exposure of trespassers to chemicals in surface water through dermal absorption and incidental ingestion is considered to be a complete pathway. However, given the depth of the quarry (range of 8 to 60 feet with most areas 40 feet) it is unlikely that site trespassers swimming in the quarry would come into contact with bottom sediment. In the rare instance when contact with sediment was made, swimming activities would likely rinse off any sediment from skin surfaces. Therefore, the potential for exposure of trespassers to quarry sediment primarily through dermal absorption is considered to be negligible and this pathway will not be evaluated.

Site observations confirm that the quarry supports aquatic life. Exposure of aquatic life to contaminants through uptake of chemicals from the surface water and/or sediments is considered to be a complete pathway. Additionally, human exposure to contaminants in surface water and sediment may occur indirectly through ingestion of fish. This pathway is considered to be complete and it will be addressed in the following section.

Exposure to Groundwater. The groundwater at or near the site is not currently used as a potable water supply. A residential well survey was conducted to identify groundwater uses near the site. This survey confirmed that there is no groundwater use within a one-half mile radius of the site. Therefore, exposure of individuals to chemicals in groundwater through ingestion, inhalation or dermal absorption is not considered to be a complete exposure pathway under current-use conditions at the site.

5.4.2 Site and Surrounding Area Under Future-Use Conditions

In evaluating the no-action alternative, possible future uses of the site must be considered because different land-use conditions may lead to exposures which do not currently occur. It was reported that a potential future use of the site was for a city park. Another possible future use of the site includes residential development as is commonly done around quarries in Ohio. Additional exposure pathways that might result from such uses are discussed below and summarized in Table 5-12.

Future use of the site as either a recreational park area or a residential area could result in exposure of park patrons or residents to chemicals of concern in soil through direct contact resulting in dermal absorption and incidental ingestion of these contaminants from hand-to-mouth contact, smoking, or eating food. For future residents, these exposures could occur on a fairly regular basis, and in both cases, these exposures would involve children, who are generally more likely to come into contact with soil and who would potentially be more affected by any soil contaminants. Exposure via this pathway will be quantitatively evaluated for future residents and for future recreational users. Soil exposures to future residents will be the worst-case exposure because exposure to recreational users will be less frequent and for shorter durations.

In the event of future development of the site, the potential exists for workers involved in the construction activities to be exposed through direct contact with contaminated soils, as well as dust generated from these materials. In addition, workers may be exposed to contaminants that have volatilized from the soil. However, significant inhalation exposure to chemicals during soil disturbance is not expected because the concentration of volatile chemicals in the surface soil is low. Although no subsurface soil samples were collected, site history and available data do not indicate wastes have been buried in the subsurface soil at the site.

With respect to future uses of groundwater, as discussed previously, local residents do not currently use private groundwater wells for drinking water. However, future use of the site could require a potable water supply and groundwater could be used for this purpose. Therefore, this exposure pathway is considered to be complete and it will be evaluated further. Inhalation of volatilized chemicals and dermal absorption of chemicals of concern in ground water while showering, washing dishes, etcetera, are not evaluated in this EA; however, they could be associated with health risks within an order of magnitude of those posed by ingestion of groundwater.

5.5 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

In order to assess risk, concentrations of chemicals of concern in various media at points of potential exposure (i.e., exposure point concentrations) must be estimated. Estimating exposure point concentrations may generally be accomplished in two ways: (1) by using the RI and Supplemental Report data to calculate direct exposure, and (2) by utilizing models in conjunction with data to predict the potential concentrations of chemicals which migrate through various environmental media prior to reaching the exposure points.

TABLE 5-12
POTENTIAL PATHWAYS OF EXPOSURE TO CONTAMINANTS ORIGINATING
AT THE REPUBLIC STEEL QUARRY UNDER FUTURE-USE CONDITIONS

Medium	Potential Routes of Exposure	Potential Receptors	Pathway Complete?
Soil	Dermal absorption, incidental ingestion	Future users of the site (park patrons or residents)	Yes.
Groundwater	Ingestion, inhalation, dermal absorption	Future users of the site	Yes.

Exposure point concentrations of chemicals of concern in soil are presented in Table 5-13. As stated in Section 5.4.1, under current conditions trespassers are the most likely group to contact these soils. For the future exposures to soils discussed in Section 5.4.2, the concentrations of the chemicals of concern currently detected in site surface soil are conservatively assumed to remain the same in the future. This assumption is based on historical evidence. Site activities were stopped 20 years ago; thus, since chemicals have remained on site for 20 years they are expected to be present in the future. Therefore, the exposure point concentrations for future residents and park patrons are also those concentrations presented in Table 5-13.

For trespassers swimming in the quarry, concentrations of chemicals of potential concern currently detected in the surface water (Table 5-14) are considered to be exposure point concentrations. As noted in Section 5.2, several chemicals were detected in sediments (Table 5-15) which were not detected in surface water. Although considered unlikely, these contaminants may desorb from the sediments into surface water. Therefore, exposure point concentrations of chemicals in the surface water will be estimated based on a conservative sediment-water partitioning model. This model is discussed in detail below.

As discussed in Section 5.4, humans may be indirectly exposed to contaminants in surface water and sediments through the ingestion of fish which take up chemicals from the surface water and sediments. Limited sampling and analysis of fish and a fish species survey in the quarry were conducted during the supplementary investigation. However, a conservative sediment/surface water exposure model (described in detail in Appendix O of the RI report) was utilized to predict the concentrations of the majority of the chemicals of concern in fish tissue. For manganese and mercury, concentrations measured in fish tissue are used (Section 2.1).

For chemicals of concern currently detected only in sediment samples, a two part bioconcentration model was derived. In part one, the contaminant concentration in the water was determined by assuming an equilibrium partitioning between the sediment and water to yield sediment pore water concentrations. Then, the pore water concentrations were assumed to be diluted by the depth of water in which the fish are considered to reside. This depth was considered to be the upper 30 feet of the quarry. Below 30 feet, dissolved oxygen concentrations drop to below one ppm. A fish in the low-oxygenated water for any period of time would be under metabolic stress and would move to more oxygenated water. Also, lower foodchain organisms such as the invertebrates which often have a lower dissolved oxygen threshold than fish require a hard substrate. Because a hard substrate is lacking at the Republic Steel Quarry site, benthic invertebrates are not expected at depth. Thus, it is not expected that fish will go below the 30-foot depth to feed. The model therefore uses the water layer where the fish are expected to reside (the upper 30 feet) to estimate dilution of the estimated sediment pore water concentrations. During warmer weather when a thermocline is present, it is expected that very little mixing between the two water layers occurs. Thus, there is a physical water barrier between the bottom layer where the contaminated sediments are located and the upper layer where the fish are expected to spend the majority of the time. During winter months when a

TABLE 5-13
CONCENTRATIONS OF CHEMICALS OF CONCERN IN SOIL
AT THE REPUBLIC STEEL SITE

Chemical	Mean Concentration (ug/kg)	Maximum Concentration (ug/kg)
Methylene Chloride	15	33
Acetone	37	150
2-Butanone	NR	78
ncPNA ^a	288	1,090
cPNA ^a	242	510
Copper	85,000	94,000
Mercury	NA	340
bis(2-ethylhexyl) phthalate ^a	NR	177
Di-n-octylphthalate ^a	NR	37
Chromium	32,000	178,000
Manganese	842,000	5,990,000
Cadmium	NA	4.5
Nickel	18.4	73
Butylbenzylphthalate ^a	NR	343

NR = Not relevant. Only 1 sample contained detectable concentrations;
therefore a geometric mean was not calculated.

NA = The mean value was below detection.

^a Concentrations of semi-volatile organic chemicals are from 2 RI samples and
2 confirmatory samples collected following removal actions.

TABLE 5-14
CONCENTRATIONS OF CHEMICALS OF CONCERN IN SURFACE WATER
AT THE REPUBLIC STEEL SITE

Chemical	Mean Concentration (ug/l)	Maximum Concentration (ug/l)
Barium	46	113
Calcium	56,700	315,000
Iron	3,070	1,600,000
Magnesium	23,600	88,900
Manganese	940	25,700
Nickel	NA	86
Vanadium	4.4	60
Cadmium	NA	12

NA - The mean concentration is below the detection level and is considered as a nondetect.

TABLE 5-15
CONCENTRATIONS OF CHEMICALS OF CONCERN IN SEDIMENT
AT THE REPUBLIC STEEL SITE

Chemical	Mean Concentration (ug/kg)	Maximum Concentration (ug/kg)
Butylbenzylphthalate	2,600	73,000
Di-n-octylphthalate	2,500	6,250
Diethylphthalate	3,730	56,000
Toluene	30	370
Methylene Chloride	NA	25
Acetone	93	1,135
Tetrachloroethene	5	38
Ethylbenzene	3.5	28
2-Butanone	37	360
ncPNA	8,430	33,200
cPNA	3,000	16,900
Pentachlorophenol	8,830	25,000
Copper	58,000	300,000
Mercury	400	730
Tin	10,000	108,000
Di-n-butylphthalate	2,160	31,000
bis(2-ethylhexyl) phthalate	4,000	68,000

NA = The mean concentration is below the detection limit.

thermocline is not expected, mixing is more likely to occur in the entire water column. Thus, in considering year round mixing over a shallow depth, the model is considered to be conservative. Also, preliminary RI data shows that most of the chemicals of concern identified in the sediments were not identified in the surface water at depth.

In the second part of the model, concentrations in fish (whole body) in the quarry were estimated by multiplying the bioconcentration factor for a chemical by the estimated water concentration of that chemical. The model assumes that no metabolism of contaminants by fish occurs. The chemical concentrations in fish have been estimated based on the assumption that water is the major source of residues. Although chemicals may also be taken up indirectly through the food web and directly from ingested sediments, at the present time insufficient experimental information is available to quantitatively include these residue sources in exposure assessments. This may result in underestimation of concentrations in fish tissue.

The model requires initial source concentrations as input. Average and maximum values of chemicals in surface water and sediment (given in Tables 5-14 and 5-15) were used to provide average and plausible maximum case estimates. Table 5-16 lists the predicted concentrations in surface water and in fish based on the model described above. It should be noted that the predicted concentrations of chemicals of potential concern in surface water will also be used as exposure point concentrations for the swimming scenario.

As discussed in Section 5.4, the groundwater at the site may potentially be used in the future as a potable water source. Exposure point concentrations for future users of this site groundwater are assumed to be the same as those measured in the groundwater and are presented in Table 5-17.

5.6 HUMAN RISK CHARACTERIZATION

According to guidelines for preparing risk assessments as part of the RI/FS process (EPA 1986, PRC 1985), the potential adverse effects on human health should be assessed where possible by comparing chemical concentrations found at or near the site with applicable or relevant and appropriate requirements (ARARs) or other guidance that has been developed for the protection of human health or the environment. If ARARs are available for all chemicals in all environmental media, then a comparison to ARARs constitutes the risk assessment. If not, quantitative risk estimates must be developed in addition to the comparison to ARARs. As noted previously in Section 5.3, a complete set of suitable ARARs or other guidance are not available for the site, therefore, a quantitative risk characterization was completed for soil, groundwater, surface water, and sediment exposure pathways. A comparison with ARARs and a quantitative risk characterization are presented below.

5.6.1 Comparison With Applicable or Relevant and Appropriate Requirements (ARARs) or Other Criteria

For the chemicals of concern at the Republic Steel site, the concentrations of those chemicals found in groundwater are compared to standards and criteria developed under the Safe Drinking Water Act and Clean Water Act. This

TABLE 5-16
ESTIMATED CONCENTRATIONS OF CHEMICALS OF CONCERN IN FISH TISSUE AT THE REPUBLIC STEEL SITE

Chemical of Concern	K _d	Concentration in Water (ug/L)		BCF	Concentration in Fish (mg/kg)	
		Average	Maximum		Average	Maximum
Barium ^a	60	NC(46)	NC(113)	NA	--	--
Tetrachloroethene ^{bg}	44	0.00126	0.011	31	0.00004	0.00034
Ethylbenzene ^{bh}	130	0.00029	0.0025	37.5	0.000011	0.000094
2-Butanone ^{ci}	0.5	1.0	8.0	0.9	0.00090	0.0072
ncPNA ^{bj}	660,000	0.00014	0.00060	920	0.00013	0.00055
cPNA ^{bj}	660,000	0.00005	0.00058	920	0.000046	0.00053
Copper ^{fk}	35	18	96	290	5.2	28
Mercury ^{ai}	10	0.44	0.81	5,000	2.2[0.20]	4.0[0.453]
Pentachlorophenol ^{bm}	6,400	0.015	0.043	7.3	0.00011	0.00031
Acetone ^{cg}	0.3	3.4	42	0.4	0.0014	0.017
Methylene Chloride ^{bg}	1.0	NA	0.28	5	NA	0.0014
bis(2-ethylhexyl) phthalate ^d	10,500	0.0042	0.061	4,500	0.019	0.27
Di-n-octylphthalate ^d	2,280	0.012	0.03	5,460	0.067	0.17
Di-n-butylphthalate ^d	20,400	0.0012	0.017	420	0.0005	0.0071
Diethylphthalate ^d	0.08	518	7,780	44	23	342
Butylbenzylphthalate ^d	2,000	0.014	0.405	1,470	0.021	0.60
Toluene ^{bg}	36	0.009	0.11	10.7	0.000096	0.0012
Tin	250	0.44	4.8	NA	--	--
Vanadium ^a	1,000	NC(4.4)	NC(60)	NA	--	--
Manganese ^{ao}	65	NC (940)	NC (25,700)	25	24[0.46]	640[3.73]
Nickel ^{op}	40	NA	NC (86)	1.1	NA	0.09
Cadmium ^a	6.5	NA	NC (12)	150	NA	1.8

NC = Not calculated. Concentration in surface water presented in parentheses.

NA = The mean value was below detection.

NR = Not relevant. Chemical was detected at only one location.

^a = Baes, et al., 1984.

^b = Mabey, et al.

^c = K

^d = Vieth, et. al., 1980. ^{oc} estimated from $\log K_{oc} = -0.55 \log Sol + 3.64$ where Sol = solubility

^e = Tyler, L.D. and McBride, M.B. 1982. Mobility and Extractability of Cadmium, Copper, Nickel and Zinc in Organic and Mineral Soil Columns. Soil Sci. 134: 198-205.

^f = Benoit, D.A., 1975.

^g = OWRS, USEPA 1980. Ambient Water Quality Criteria Documents for [Specific Chemical].

^h = EPA 1980 AWQC ethyl benzene EPA 440/5-80-048.

ⁱ = Dawson, G.W. et al., 1980.

^j = Gerhart, E.H. and Carlson, R.M. 1978.

^k = Lind, D. et al. Regional Copper-Nickel Study Aquatic Toxicology Progress Report (Manuscript) (as cited in EPA 1980b).

^l = Perry and Chilton, 1973.

^m = EPA, 1986 AWQC PCP February 18, 1986 Draft.

^o = Chapman, W.H. et al., 1968.

^p = Calamari, D., et al, 1982.

-- = Bioconcentration factors were not available for these metals.

[] = Concentrations measured in fish during the supplemental report.

TABLE 5-17
CONCENTRATIONS OF CHEMICALS OF CONCERN IN GROUNDWATER
AT THE REPUBLIC STEEL SITE

Chemical	Mean Concentration (ug/L)	Maximum Concentration (ug/L)
Lead	NR	19
Zinc	51	106
Pentachlorophenol	NR	5 ^a
Phenol	NR	10 ^b
Barium	64	114
Beryllium	1	2.1
Chromium	8.4	20
Copper	11	28
Manganese	1,490	11,600
Nickel	117	131
Silver	NR	4.1
Vanadium	29	57
Aluminum	2,600	11,600
Benzoic Acid	NR	42
Calcium	198,000	470,000
Cobalt	NR	18
Iron	28,700	571,000
Potassium	7,200	37,200
Sodium	76,600	324,000
Cadmium	NR	6.4
bis(2-ethylhexyl) phthalate	6.3	11
di-n-butylphthalate	NR	3.9

NR = Not relevant. Only 1 sample contained detected concentrations; therefore, a geometric mean was not calculated.

^a The value is estimated in the data base and is one half the detection limit.

^b The detection limit of phenol is 10 ug/L.

comparison will be applied to the appropriate chemicals for drinking water in Table 5-18. Table 5-19 provides standards for surface water.

5.6.1.1 Groundwater

Potential ARARs which have been identified for groundwater are presented in Table 5-18. Guidance issued by USEPA (EPA 1987b) states that "The actual or potential uses of water, and the manner in which it is used, will determine what kinds of requirements may be applicable or relevant and appropriate." Other considerations that EPA note are that (1) drinking water standards are neither applicable nor relevant and appropriate for groundwater that is not suitable for drinking and that does not affect drinkable groundwater, and (2) that MCLs are generally the applicable or relevant and appropriate standard for water that is or may be used for drinking, being applicable at the tap where the water will be provided directly to 25 or more people or will be supplied to 15 or more service connections. Otherwise, where groundwater is to be used for drinking, MCLs are relevant and appropriate requirements. As part of this same guidance, USEPA notes that where there are no specific ARARs for a chemical or where such ARARs are not sufficient to be protective, pertinent health advisories should be identified and used.

In addition, the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires that promulgated State environmental standards be included as potential ARARs. Ohio may adopt the federal MCLs and SMCLs as State drinking water standards when federal standards are more stringent than Ohio standards (Susan MacMillan, Ohio EPA, personal communication). However, there is inevitably a time-lag before the States can adopt new Federal MCLs.

In the following discussion, in which concentrations of site-related chemicals in groundwater in monitoring wells are compared with potential ARARs, the most appropriate of available ARARs or guidance for the aquifer and its use will be identified and used for the comparison. Concentrations detected in the wells during the current sampling effort were used in the comparison.

As indicated in Table 5-18, maximum and average concentrations of beryllium and iron exceed the State and Federal groundwater ARARs. Additionally, average and maximum concentrations of manganese and the maximum concentration of phenol exceed the Ohio Water Quality Standards for Public Water Supplies.

5.6.1.2 Surface Water.

Potential ARARs for surface water are presented in Tables 5-8 and 5-19. Concentrations of site-related chemicals will be compared to ARARs in this section. The results of this comparison are discussed below.

Table 5-19 shows that average and maximum concentrations of manganese and mercury exceed the Federal Water Quality Criteria for consumption of fish. Mercury was not observed in detectable concentrations in any samples of surface water; mercury concentrations were calculated by the sediment/water partitioning model described in Appendix O of the RI. Concentrations in the water column are expected to be lower than those predicted by this conservative model.

TABLE 5-18
COMPARISON OF GROUNDWATER CONCENTRATIONS AT
THE REPUBLIC STEEL SITE WITH ARARs

Chemical	Concentration in Groundwater ug/L		Water Quality Criteria	
	Average	Maximum	Ohio Public Water Supply Standards	Federal
Barium	64	114	1000 ^c	1,000 MCL
Beryllium	1	2.1	0.068 ^c	0(3.9 ng/l)
Manganese	1,490	11,600	50 ^c	--
Chromium	8.4	20	50 ^c	50 MCL
Copper	11	28	1,000 ^c	--
Lead	NR	19	50 ^c	50 MCL
Nickel	117	131	610 ^c	15.4 WQC ^a
Zinc	51	106	5,000 ^c	5,000 WQC ^b (organoleptic)
Pentachlorophenol	NR	5	1,000 ^c	--
Phenol	NR	10	1 ^c	3,500 WQC ^a
Aluminum	2,600	11,600	--	--
Calcium	190,000	470,000	--	--
Cobalt	NR	18	--	--
Silver	NR	4.1	50 ^c	50 WQC ^a
Vanadium	29	57	--	--
Iron	28,700	571,000	300 ^c	300 MCL ^b
Potassium	7,200	37,200	--	--
Sodium	76,600	324,000	--	--
Cadmium	NR	6.4	10 ^c	10 MCL
Benzoic Acid	NR	42	--	--
bis(2-ethylhexyl) phthalate	6.3	11	18 ^c	21,000 WQC ^a
Di-n-butylphthalate	NR	3.9	2,700	44,000 WQC ^a

NR = Not relevant. Chemical was detected at only 1 location.

^a These adjusted criteria, for drinking water ingestion only, were derived from published EPA ambient water quality criteria (45 FR 79318-79379, November 28, 1980) for combined fish and drinking water ingestion and for fish ingestion alone. The adjusted values are not official EPA ambient water quality criteria, but may be appropriate for Superfund sites with contaminated groundwater. In derivation of these values, intake was assumed to be 2 liters/day for drinking water and 6.5 grams/day for fish, and human body weight was assumed to be 70 kilograms. Bioconcentration factors, cancer potency factors and acceptable daily intake were those used for water quality criteria development.

^b Criteria designated as organoleptic are based on taste and odor effects, not human health effects. Health-based water quality criteria is not available for this chemical.

^c Human-health 30-day average.

TABLE 5-19
COMPARISON OF SURFACE WATER CONCENTRATIONS AT THE REPUBLIC STEEL SITE
WITH AWQC TOXICITY VALUES

Chemical	Concentration in Surface Water ug/L		Federal Water Quality Criteria (ug/L) for Consumption of Fish
	Average	Maximum	
Nickel	NA	86	100
Vanadium	4.4	60	--
Barium	46	113	--
Manganese	940	25,700	100 ug/l
ncPNA ^a	0.00014	0.00060	--
cPNA ^a	0.000050	0.00058	0.031
Pentachlorophenol ^a	0.015	0.043	--
Acetone ^a	3.4	42	--
Tetrachloroethene ^a	0.00126	0.011	--
Ethylbenzene ^a	0.00029	0.0025	3,280
2-Butanone ^a	1.0	8.0	--
bis(2-ethylhexyl) phthalate ^a	0.0042	0.061	--
Copper ^a	18	96	--
Mercury ^a	0.44	0.81	0.146
Methylene Chloride ^a	NA	0.28	--
Butylbenzylphthalate ^a	0.014	0.405	--
Di-n-butylphthalate ^a	0.0012	0.017	--
Toluene ^a	0.009	0.11	424,000
Di-n-octylphthalate ^a	0.012	0.03	--
Diethylphthalate	518	7,780	1,800,000
Tin	0.044	0.0048	--
Cadmium	NA	12	--

NA = Not applicable. The mean value was below detection.

^a = Calculated concentration based on modeling from sediment.

5.6.2 Quantitative Risk Characterization

5.6.2.1 Quantitative Risk Assessment Methodology

To quantitatively assess the potential risks to human health associated with the current-use and future-use exposure scenarios considered in this assessment, the concentrations of chemicals in relevant environmental media at points of potential exposure (exposure point concentrations) developed in Section 5.4.3 are converted to chronic daily intakes (CDIs). CDIs are expressed as the amount of a substance taken into the body per unit body weight per unit time, or mg/kg/day. A CDI is averaged over a lifetime for carcinogens (EPA 1986) and over the exposure period for noncarcinogens (EPA 1986).

For potential carcinogens, excess lifetime cancer risks are obtained by multiplying the daily intake of the contaminant under consideration by its cancer potency factor. EPA recommends that the total cancer risk to individuals resulting from exposure at a Superfund site be reduced to zero where possible. EPA has implemented actions under Superfund associated with total cancer risks ranging from 10^{-4} to 10^{-7} (i.e., one excess cancer in every 10,000 or 10,000,000 individuals, respectively, exposed throughout their lifetime) (EPA 1986). A risk level of 10^{-6} , representing an upperbound probability that one excess cancer case in 1,000,000 individuals might result from exposure to the potential carcinogen, is often used as a benchmark by regulatory agencies. Accordingly, 10^{-6} will be the benchmark risk level used in this report.

Potential risks for noncarcinogens are presented as the ratio of the chronic daily intake exposure to the reference dose (CDI:RfD). The sum of all of the ratios of chemicals under consideration is called the hazard index. The hazard index is useful as a reference point for gauging the potential effects of environmental exposures to complex mixtures. In general, hazard indices which are less than one are not likely to be associated with any health risks, and are therefore less likely to be of regulatory concern than hazard indices greater than one. A conclusion should not be categorically drawn, however, that all hazard indices less than one are "acceptable" or that hazard indices of greater than one are "unacceptable". This is a consequence of the perhaps one order of magnitude or greater uncertainty inherent in estimates of the RfD and CDI in addition to the fact that the uncertainties associated with the individual terms in the hazard index calculation are additive.

In accordance with EPA's guidelines for evaluating the potential toxicity of complex mixtures (EPA 1986), it was assumed that the toxic effects of the site-related chemicals would be additive. Thus, lifetime excess cancer risks and the CDI:RfD ratios were summed to indicate the potential risks associated with mixtures of potential carcinogens and noncarcinogens, respectively. In the absence of specific information on the toxicity of the mixture to be assessed or on similar mixtures, EPA guidelines generally recommend assuming that the effects of different components on the mixtures are additive when affecting a particular organ or system. Synergistic or antagonistic interactions may be taken into account if there is specific information on particular combinations of chemicals. In this risk assessment, it was assumed that the potential effects of the site-related chemicals would be additive. Equations used to estimate contaminant intakes, are presented in Appendix B.

To determine the rates of contaminant intake for the populations likely to be at risk of exposure, scenarios depicting the activities of trespassers (current), park patrons (future), and residents (future) have been constructed. For each scenario, two cases were considered - an average case and a plausible maximum case. The average case assumes average estimates of exposure parameters (e.g., average frequency and duration of exposure and quantity of contaminated media contacted) and uses the geometric mean concentrations of the contaminants found in relevant environmental media. On the other hand, the plausible maximum case assumes the highest estimates of the exposure parameters and considers the maximum concentrations of the contaminants found in the media. Exposure characteristic of the plausible maximum case are possible; however, they are likely to apply to only a small fraction of the population.

5.6.2.2 Current-Use Scenario: Intermittent Exposure of Trespassers to Contaminated Soils

Under this scenario, it is assumed that trespassers may enter the property and come into contact with contaminated soils. Contaminants may then be absorbed through the skin or be inadvertently ingested by smoking or eating, or in the case of children, by placing soiled objects in the mouth.

To calculate the amount of soil taken in by trespassers several assumptions are made. These assumptions are summarized in Table 5-20. The trespassers are assumed to be youths between the ages of 13 and 18 having an average body weight of 60 kg. They are expected to visit the site an average of 24 and a maximum of 40 times per year over a period of about 5 years under the average and plausible maximum exposure scenarios, respectively.

Based on LaGoy (1987), it was assumed that these youths will incidentally ingest approximately 50 mg and possibly up to 100 mg of contaminated soil per visit. However, depending on the compounds, only a fraction of the contamination in the soil that is ingested will be absorbed. These more recently generated values have replaced values provided in the Superfund Public Health Evaluation by Kimbrough et al. (1984). In calculating the intake of contaminants from ingestion of contaminated soil from the Republic Steel site, the following percentages of gastrointestinal absorption for the different chemicals are assumed: 15-45 percent of the carcinogenic PNAs are absorbed; 50-100 percent of the noncarcinogenic PNAs are absorbed; and 100 percent of all other chemicals are absorbed. (Estimated from Poiger & Schlatter, 1980; McConnel et al., 1984; Lucier et al., 1986; VandenBerg, et al., 1985, 1986; and Galey et al. 1976).

In addition to inadvertently ingesting soils, trespassers may be exposed to soil contaminants by direct dermal contact and subsequent absorption. Based on the work of Schaum (1984), daily soil contact rates of 0.5 mg/cm² to 1.5 mg/cm² have been assumed for the average and maximum exposure scenarios, respectively. An area of exposed skin surface of 1,980 cm² has been estimated for the hands and forearms (EPA 1985). Dermal absorption of PNAs is based on Feldman and Maibach (1970) with consideration for soil matrix effects. One

TABLE 5-20
ASSUMPTIONS USED TO ESTIMATE EXPOSURE TO TRESPASSERS VIA CONTACT
WITH SOIL UNDER CURRENT-USE CONDITIONS AT THE REPUBLIC STEEL SITE

Parameter	Average Case	Plausible Maximum Case
Ages Exposed	13-18 years	13-18 years
Frequency of Exposure	24 days/yr	40 days/yr
Period of Exposure	5 years	5 years
Incidental Ingestion ^a	50 mg/day	100 mg/day
Oral absorption factor ^b		
Metals	1	1
cPNAs	0.15	0.45
ncPNAs	0.50	1
Other organic chemicals	1	1
Daily Soil Contact Rate ^c	0.5 mg/cm ² /day	1.5 mg/cm ² /day
Area of Exposed Skin ^d	1,980 cm ²	1,980 cm ²
Dermal Absorption Factor ^e		
Metals	0	0
PNAs	0.003	0.03
Other organic chemicals	0.01	0.04
Average Body Weight	60 kg	60 kg
Exposure Point Concentrations ^f	Mean	Maximum

^a Based on the work of LaGoy 1987.

^b This factor represents the percentage of contaminants absorbed from ingested soil.

^c Based on the work of Schaum 1984.

^d Area of hands and forearms EPA 1985.

^e This factor represents the percentage of contaminants absorbed through the skin.

^f These concentrations are shown in Table 5-13.

percent of the remaining organic chemicals in the soil is assumed to be absorbed through the skin in the average case, and 4 percent of the remaining organic chemicals is absorbed in the plausible maximum case (based on Feldman and Maibach 1970).

Chronic daily intakes and potential carcinogenic and noncarcinogenic risks calculated using the above assumptions and the equations presented in Appendix B are presented in Table 5-21. As indicated in Table 5-21, the estimated intakes of the chemicals of potential concern are less than the available criteria for protection against noncarcinogenic effects and the hazard index for both the average and plausible maximum exposure scenarios is less than one. Thus, noncarcinogenic health risks are not likely to result from exposure to the chemicals evaluated. Additionally, under the average and plausible maximum exposure assumptions, the upperbound excess lifetime cancer risks are less than 10^{-6} .

5.6.2.3 Current-Use Scenario: Intermittent Exposure of Trespassers to Contaminated Surface Water While Swimming.

Under this exposure scenario, it is assumed that older children trespass onto the site and swim in the quarry. These individuals may be exposed to chemicals of concern in the quarry water through dermal absorption and incidental ingestion. To evaluate this exposure scenario, it is assumed that individuals would use these lakes for swimming between the ages of 13 to 18 years. It also is assumed that individuals swim two times a week during the warmest 4 months of the year for the average case and four times a week during the same months for the plausible maximum case. These and other assumptions used to calculate exposures while swimming are summarized in Table 5-22.

Significant dermal absorption of the metals detected in the quarry is not expected because the concentrations are low, and because the permeability of even hydrated skin to metal ions is low. Further, the episodic nature and short-duration of swimming events also minimizes the potential for significant exposure. As a result, intakes from dermal absorption of metals while swimming is not evaluated. However, dermal absorption of organic chemicals will be evaluated assuming that a contaminant is carried through the skin as a solute in water (rather than being preferentially absorbed independently of the water). The skin surface area available for contact with water was estimated and multiplied by the dermal permeability constant for water (8×10^{-4} cm/hr) to estimate dermal absorption of organic chemicals.

In addition to dermal contact, it is possible that a person may accidentally swallow water while swimming. For the purpose of evaluating this potential exposure, it is assumed that an individual will ingest approximately 100 milliliters (about 3.5 fluid ounces) of water during each swimming event. All of the chemicals of concern in the quarry water will be assessed in this exposure pathway.

TABLE 5-21

CHRONIC DAILY INTAKES AND POTENTIAL RISKS TO TRESPASSERS VIA DIRECT CONTACT
WITH SOIL UNDER CURRENT-USE CONDITIONS AT THE REPUBLIC STEEL SITE (a)

POTENTIAL CARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (b) (mg/kg-day)		Potency Factor (mg/kg-day) ⁻¹	Lifetime Upper Bound Excess Cancer Risk	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Bis(2-ethylhexyl)phthalate (c)	NC	5.05E-09	1.4E-02	NC	7E-11
cPNA (c)	1.98E-10	8.92E-09	1.2E+01	2E-09	1E-07
Methylene chloride	7.03E-11	9.42E-10	7.5E-03	5E-13	7E-12
TOTAL	---	---	---	2E-09	1E-07
NONCARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (b) (mg/kg-day)		Reference Dose (RfD) (mg/kg-day)	CDI:RfD	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Acetone	2.43E-09	5.99E-08	1.0E-01	2E-08	6E-07
Bis(2-ethylhexyl)phthalate (c)	NC	7.07E-08	2.0E-02	NC	4E-06
2-Butanone (MEK)	NC	3.12E-08	5.0E-02	NC	6E-07
Butylbenzylphthalate (c)	NC	6.26E-08	2.0E-01	NC	3E-07
Cadmium	NC	8.22E-10	1.0E-03	NC	8E-07
Chromium	1.75E-06	3.25E-05	5.0E-03	4E-04	7E-03
Copper	4.66E-06	1.72E-05	3.7E-02	1E-04	5E-04
Manganese	4.61E-05	1.09E-03	2.2E-01	2E-04	5E-03
Mercury	NC	6.21E-08	3.0E-04	NC	2E-04
Methylene chloride	9.85E-10	1.32E-08	6.0E-02	2E-08	2E-07
ncPNA (c)	8.83E-09	3.76E-07	4.0E-03	2E-06	9E-05
Nickel	7.34E-10	1.33E-08	2.0E-02	4E-08	7E-07
HAZARD INDEX	---	---	---	<1 (7E-4)	<1 (1E-2)

(a) The assumptions made in developing the average and plausible maximum exposure cases are shown in Table 5-20. Exposure point concentrations are presented in Table 5-13.

(b) CDIs represent the total intake through dermal absorption and incidental ingestion.

(c) Concentrations of semi-volatile organic chemicals are from 2 RI samples and 2 confirmation samples collected following removal actions.

NC = Not calculated; chemical only detected in one sample or the mean value was less than the detection limit.

TABLE 5-22
ASSUMPTIONS USED FOR CALCULATING CHEMICAL INTAKES
DUE TO SWIMMING IN THE REPUBLIC STEEL QUARRY

Parameter	Plausible Average Exposure	Maximum Exposure
Age of exposed individual	13-18 years	13-18 years
Frequency of swimming	32 events/year	64 events/year
Duration of exposure event	1 hr	1 hr
Years of exposure	5	5
Average weight over period of exposure	60 kg	60 kg
Amount of water ingested while swimming	100 ml/event	100 ml/event
Skin surface area ^a	15,300 cm ²	15,300 cm ²
Flux rate of water (and chemical) across skin	0.5 mg/cm ² /hr	1.0 mg/cm ² /hr

^a Corresponding to the 50th percentile among 12-15 year old males (EPA 1985d).

Chronic daily intakes and risks, calculated using the above assumptions and equations presented in Appendix B, are presented in Table 5-23. Subchronic daily intakes are not calculated, as proposed in the Superfund PHE, because concentrations at Superfund sites are most often at a level to potentially promote chronic effects. If levels of contaminants were high enough to promote subchronic effects, it is assumed that these effects would have been observed at the site. The endangerment assessment uses average and plausible maximum concentrations to calculate average and upper bound risk.

As indicated in Table 5-23, the hazard index for both the average and plausible maximum exposure scenarios is less than one. Thus, noncarcinogenic health risks are not likely to result from exposure through swimming.

Additionally, as indicated in Table 5-23, the upperbound excess lifetime cancer risks are less than 10^{-6} for the average and maximum scenarios.

5.6.2.4 Current-Use Scenario: Intermittent Exposure of Trespassers to Contaminated Fish.

For the purposes of this assessment, it is assumed that fishing occurs during four months of the year for ten years as an average case and 20 years as a maximum case, and that enough fish is assumed to be caught to occasionally feed a family. Under this scenario, it is assumed that fish are caught and consumed once a week for 4 months for a total of 16 meals each year. The average quantity of fish consumed per meal is 113 g (corresponding to the 50th percentile among fish eaters, as reported by Pao et al. 1982) and the plausible maximum amount ingested is 340 g (corresponding to the 95th percentile). The average exposed family member is assumed to weigh 70 kg. The exposure assumptions are summarized in Table 5-24. CDIs and calculated risk estimates (calculated using the equations in Appendix B for noncarcinogens and carcinogens are presented in Table 5-25.

As indicated in Table 5-25, under the average exposure conditions, the hazard index is less than one, indicating that noncarcinogenic health risks are not likely to result. Although for the plausible maximum exposure scenario the hazard index is equal to one, the chronic daily intake does not exceed the reference dose for any one chemical. Additionally, only two of the three chemicals that primarily contribute to the hazard index, cadmium, copper and mercury have the same endpoint of toxicity. These are cadmium and mercury which both affect the kidneys and the central nervous system. It should be noted that cadmium was added as a chemical of concern in this EA, and was detected in only one of twenty samples.

As shown in Table 5-25 the upperbound excess lifetime cancer risks associated with ingestion of fish is less than 10^{-6} under the average and maximum exposure scenarios.

5.6.2.5 Future-Use Scenario: Lifetime Exposure of Residents to Contaminated Soils

Residential development of the Republic Steel site may allow future residents to be exposed to contaminated soils. Children are the most likely population at risk because their daily intake of soil may be high as a result of playing

TABLE 5-23

CHRONIC DAILY INTAKES AND POTENTIAL RISKS TO INDIVIDUALS SWIMMING IN THE QUARRY
UNDER CURRENT-USE CONDITIONS AT THE REPUBLIC STEEL SITE (a)

POTENTIAL CARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (mg/kg-day)		Potency Factor (mg/kg-day) ⁻¹	Lifetime Upper Bound Excess Cancer Risk	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Bis(2-ethylhexyl)phthalate	4.95E-11	1.44E-09	1.4E-02	7E-13	2E-11
cPNA	5.89E-13	1.37E-11	1.2E+01	7E-12	2E-10
Methylene chloride	NC	6.60E-09	7.5E-03	NC	5E-11
Tetrachloroethene	1.48E-11	2.59E-10	5.1E-02	8E-13	1E-11
TOTAL	---	---	---	8E-12	3E-10
NONCARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (mg/kg-day)		Reference Dose (RfD) (mg/kg-day)	CDI:RfD	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Acetone	5.61E-07	1.39E-05	1.0E-01	6E-06	1E-04
Barium	6.72E-06	3.30E-05	5.0E-02	1E-04	7E-04
Bis(2-ethylhexyl)phthalate	6.93E-10	2.01E-08	2.0E-02	3E-08	1E-06
2-Butanone	1.65E-07	2.64E-06	5.0E-02	3E-06	5E-05
Butylbenzylphthalate	2.31E-09	1.34E-07	2.0E-01	1E-08	7E-07
Cadmium	NC	3.51E-06	5.0E-04	NC	7E-03
Copper	2.63E-06	2.81E-05	3.7E-02	7E-05	8E-04
Diethylphthalate	8.54E-05	2.57E-03	8.0E-01	1E-04	3E-03
Di-n-butylphthalate	1.98E-10	5.61E-09	1.0E-01	2E-09	6E-08
Ethylbenzene	4.78E-11	8.24E-10	1.0E-01	5E-10	8E-09
Manganese	1.37E-04	7.51E-03	2.2E-01	6E-04	3E-02
Mercury	6.43E-08	2.37E-07	3.0E-04	2E-04	8E-04
Methylene chloride	NC	9.23E-08	6.0E-02	NC	2E-06
ncPNA	2.31E-11	1.98E-10	4.0E-03	6E-09	5E-08
Nickel	NC	2.51E-05	2.0E-02	NC	1E-03
Pentachlorophenol	2.47E-09	1.42E-08	3.0E-02	8E-08	5E-07
Tetrachloroethene	2.08E-10	3.63E-09	1.0E-02	2E-08	4E-07
Tin	6.43E-08	1.40E-06	6.4E-01	1E-07	2E-06
Toluene	1.48E-09	3.63E-08	3.0E-01	5E-09	1E-07
Vanadium	6.43E-07	1.75E-05	7.0E-03	9E-05	3E-03
HAZARD INDEX	---	---	---	<1 (1E-3)	<1 (5E-2)

(a) The assumptions made in developing the average and plausible maximum exposure cases are shown in Table 5-22. Exposure point concentrations are presented in Table 5-16.

NC = Not calculated; chemical only detected in one sample or the mean value was less than the detection limit.

TABLE 5-24
ASSUMPTIONS USED TO ESTIMATE EXPOSURE TO EATING FISH
FROM THE REPUBLIC STEEL SITE

Parameter	Average Case	Plausible Maximum Case
Frequency of Fish Meals	16 meals/year	16 meals/year
Years of Exposure	10 years	20 years
Quantity of Fish Ingested Per Meal ^a	113 g	340 g
Average Body Weight of Individual	70 kg	70 kg

^a Average and maximum values correspond to the 50th and 95th percentile of the amount of fish consumed by fish eaters, Pao et al. 1982.

TABLE 5-25

CHRONIC DAILY INTAKES AND POTENTIAL RISKS TO INDIVIDUALS VIA CONSUMPTION
OF FISH UNDER CURRENT-USE CONDITIONS AT THE REPUBLIC STEEL SITE (a)

POTENTIAL CARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (mg/kg-day)		Potency Factor (mg/kg-day) ⁻¹	Lifetime Upper Bound Excess Cancer Risk	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Bis(2-ethylhexyl)phthalate	1.92E-07	1.64E-05	1.4E-02	3E-09	2E-07
cPNA	4.65E-10	3.22E-08	1.2E+01	5E-09	4E-07
Methylene chloride	NC	8.52E-08	7.5E-03	NC	6E-10
Tetrachloroethene	4.04E-10	2.07E-08	5.1E-02	2E-11	1E-09
TOTAL	---	---	---	8E-09	6E-07
NONCARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (mg/kg-day)		Reference Dose (RfD) (mg/kg-day)	CDI:RfD	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Acetone	9.91E-08	3.62E-06	1.0E-01	1E-06	4E-05
bis(2-Ethylhexyl)phthalate	1.34E-06	5.75E-05	2.0E-02	7E-05	3E-03
2-Butanone	6.37E-08	1.53E-06	5.0E-02	1E-06	3E-05
Butylbenzylphthalate	1.49E-06	1.28E-04	2.0E-01	7E-06	6E-04
Cadmium	NC	3.83E-04	1.0E-03	NC	4E-01
Copper	3.68E-04	5.96E-03	3.7E-02	1E-02	2E-01
Diethylphthalate	1.63E-03	7.28E-02	8.0E-01	2E-03	9E-02
Di-n-butylphthalate	3.54E-08	1.51E-06	1.0E-01	4E-07	2E-05
Ethylbenzene	7.78E-10	2.00E-08	1.0E-01	8E-09	2E-07
Manganese (b)	3.26E-05	7.94E-04	2.2E-01	1E-04	4E-03
Mercury (b)	1.42E-05	9.65E-05	3.0E-04	5E-02	3E-01
Methylene chloride	NC	2.98E-07	6.0E-02	NC	5E-06
ncPNA	9.20E-09	1.17E-07	4.0E-03	2E-06	3E-05
Nickel	NC	1.92E-05	2.0E-02	NC	1E-03
Pentachlorophenol	7.78E-09	6.60E-08	3.0E-02	3E-07	2E-06
Tetrachloroethene	2.83E-09	7.24E-08	1.0E-02	3E-07	7E-06
Toluene	6.79E-09	2.55E-07	3.0E-01	2E-08	9E-07
HAZARD INDEX	---	---	---	<1 (6E-02)	=1 (1)

(a) The assumptions made in developing the average and plausible maximum exposure cases are shown in Table 5-24. Exposure point concentrations are presented in Table 5-16.

(b) Based on measured concentrations in fish tissue.

NC = Not calculated; chemical only detected in one sample or the mean value was less than the detection limit.

or crawling on their hands and subsequently placing their hands in their mouths. Some children also directly eat soil in a behavior known as habitual pica (this extreme behavior would result in a greater potential risk than what is calculated). This behavior, however, is primarily associated with medical disorders such as malnutrition and is thus not evaluated in this EA. Adults also come into contact with and may inadvertently ingest contaminated soil.

The amounts of soil ingested by individuals differs with age. Estimates of intakes by different age groups has been discussed by LaGoy (1987). Children from 1-6 years old may ingest 100 to 500 mg per day; and children from 6 to 12 years old may ingest 50 to 250 mg per day. Adults and children over the age of 12 are assumed to ingest 25 to 100 mg of soil per day. Over a lifetime, a person is assumed to ingest 30 to 140 mg per day. These values represent time-weighted averages of the values present for each age group.

The length of time the residents spend outdoors also differs with age. Based on EPA (1984) for the average and maximum scenarios, children are assumed to spend an average of 125 days and a maximum of 250 days per year outdoors. The average adult is assumed to spend one day a week outdoors on yard work from May to October (25 days/year); while the avid gardener is assumed to spend up to four days a week outdoors from May to October (100 days/year). Based on these values, time-weighted averages of lifetime frequencies of exposure were calculated to be 40 and 125 days/year for the average and assumed maximum scenarios, respectively.

Residents directly contacting contaminated soils will be exposed not only by ingestion, but through dermal absorption of chemicals. The average lifetime soil contact rates are assumed to be 0.5 mg/cm² and 1.5 mg/cm² under average and plausible maximum exposure conditions respectively (Schaum 1984). The surface area exposed for children in different age groups was derived from information provided by EPA (1985) and involved summing the percentages of total body surface area contributed by the hands, lower arms (40 percent of the arms), and the lower legs (40 percent of the legs) for each age group and multiplying the value by 90 percent of the total body surface area for male children. The adult values for surface area exposed included the area of the hand and forearms only (EPA 1985) since these areas are most likely to be exposed to soil contaminants. To calculate the exposure parameters for a lifetime resident, the values for the different age groups were averaged taking into consideration the length of time the person spends in that age group (i.e., the lifetime values represent time weighted-average values). Table 5-26 summarizes these assumptions. Table 5-27 presents CDIs and calculated risk estimates for noncarcinogens and carcinogens.

As indicated in Table 5-27 the hazard index for both the average and plausible maximum case is less than one indicating that noncarcinogenic health risks will not result from future residential exposure to soils. For carcinogens, Table 5-27 illustrates that the potential upperbound excess lifetime cancer risk is less than 10⁻⁶ under the average case and equal to 5x10⁻⁶ under the plausible maximum exposure scenario. The maximum risk is primarily due to exposure to cPNAs in the area near the steel plant yard where SS-004 was collected.

TABLE 5-26
ASSUMPTIONS USED TO ESTIMATE EXPOSURE TO RESIDENTS VIA DIRECT
CONTACT WITH SOIL--FUTURE-USE SCENARIO
AT THE REPUBLIC STEEL SITE

Parameter	Average Case	Plausible Maximum Case
Frequency of Exposure		
Children (1-12 years)	125 days/year	250 days/year
Adults (12-70 years)	25 days/year	100 days/year
Lifetime (0-70 years)	40 days/year	125 days/year
Period of Exposure		
Children aged 1-6 years	5 years	5 years
Children aged 6-12 years	6 years	6 years
Ages 12 and older	59 years	59 years
Lifetime (0-70 years)	70 years	70 years
Incidental Ingestion Rate ^a		
Children aged 1-6 years	100 mg/day	500 mg/day
Children aged 6-12 years	50 mg/day	250 mg/day
Ages 12 and older	25 mg/day	100 mg/day
Lifetime (0-70 years)	50 mg/day	140 mg/day
Oral Absorption factor ^b		
cPNAs	0.15	0.45
ncPNAs	0.50	1.00
Other organic chemicals & metals	1.00	1.00
Daily Soil Contact Rate ^c	0.5 mg/cm ²	1.5 mg/cm ²
Area of Exposed Skin ^d		
Children ages 1-6 years	1730 cm ²	1730 cm ²
Children aged 6-12 years	2920 cm ²	2920 cm ²
Ages 12 and older	1980 cm ²	1980 cm ²
Lifetime (0-70 years)	2040 cm ²	2040 cm ²
Dermal Absorption Factor ^e		
Metals	0	0
PNAs	0.003	0.03
Other organic chemicals	0.01	0.04
Average Body Weight		
Children aged 1-6 years	15 kg	15 kg
Children aged 6-12 years	30 kg	30 kg
Ages 12 and older	70 kg	70 kg
Lifetime (0-70 years)	60 kg	60 kg
Exposure Point Concentrations ^f	Geometric Mean	Maximum

^a Based on the work of LaGoy 1987.

^b This factor represents the percentage of contaminants absorbed from ingested soil.

^c Based on the work of Schaum 1984.

^d EPA 1985. Adult values were calculated based on the exposure of the hands and forearms. Children's values were calculated based on the exposure of the hands, lower legs and lower arms.

^e This factor represents the percentage of contaminants absorbed through the skin.

^f These concentrations are shown in Table 5-13.

^g Lifetime values are weighted averages of values for different age groups.

TABLE 5-27

CHRONIC DAILY INTAKES AND POTENTIAL RISKS TO RESIDENTS VIA DIRECT CONTACT
WITH SOIL UNDER FUTURE-USE CONDITIONS AT THE REPUBLIC STEEL SITE (a)

POTENTIAL CARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (b) (mg/kg-day)		Potency Factor (mg/kg-day) ⁻¹	Lifetime Upper Bound Excess Cancer Risk	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Bis(2-ethylhexyl)phthalate (c)	NC	2.65E-07	1.4E-02	NC	4E-09
cPNA (c)	4.67E-09	4.51E-07	1.2E+01	5E-08	5E-06
Methylene chloride	1.65E-09	4.94E-08	7.5E-03	1E-11	4E-10
TOTAL	---	---	---	5E-08	5E-06
NONCARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (b) (mg/kg-day)		Reference Dose (RfD) (mg/kg-day)	CDI:RfD	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Acetone	4.07E-09	2.25E-07	1.0E-01	4E-08	2E-06
Bis(2-ethylhexyl)phthalate (c)	NC	2.65E-07	2.0E-02	NC	1E-05
2-Butanone (MEK)	NC	1.17E-07	5.0E-02	NC	2E-06
Butylbenzylphthalate (c)	NC	5.14E-07	2.0E-01	NC	3E-06
Cadmium	NC	3.60E-09	1.0E-03	NC	4E-06
Chromium	2.92E-06	1.42E-04	5.0E-03	6E-04	3E-02
Copper	7.76E-06	7.51E-05	3.7E-02	2E-04	2E-03
Manganese	7.69E-05	4.79E-03	2.2E-01	3E-04	2E-02
Mercury (inorganic)	NC	2.72E-07	3.0E-04	NC	9E-04
Methylene chloride	1.65E-09	4.94E-08	6.0E-02	3E-08	8E-07
ncPNA (c)	1.48E-08	1.44E-06	4.0E-03	4E-06	4E-04
Nickel	1.22E-09	5.83E-08	2.0E-02	6E-08	3E-06
HAZARD INDEX	---	---	---	<1 (1E-3)	<1 (5E-2)

(a) The assumptions made in developing the average and plausible maximum exposure cases are shown in Table 5-26. Exposure point concentrations are presented in Table 5-13.

(b) CDIs represent the total intake through dermal absorption and incidental ingestion.

(c) Concentrations of semi-volatile organic chemicals are from 2 RI samples and 2 confirmation samples collected following removal actions.

NC = Not calculated; chemical only detected in one sample or the mean value was less than the detection limit.

5.6.2.6 Future-Use Scenario: Exposure of Park Patrons to Contaminated Soils

The assumptions for exposure of park patrons to contaminated soils in the event that the site is converted into a park are similar to the assumptions for exposure of current trespassers, except that the frequency of exposure in the average case is assumed to be 16 times per year and in the plausible maximum case 40 times per year. The period of exposure will be 20 years for both the average case and plausible maximum cases. All other assumptions (e.g., soil ingestion rates, absorption factors etc.) other than the ones described will be identical to those present Table 5-20 for trespassers. Table 5-28 lists these assumptions for park patrons. CDIs and calculated risk estimates for noncarcinogens and carcinogens are given in Table 5-29.

Table 5-29 shows that the hazard index for both the average and plausible maximum scenarios is less than one indicating that noncarcinogenic health risks will not result under the conditions evaluated. Table 5-29 illustrates that the upperbound excess lifetime cancer risk is less than 10^{-6} under the average and plausible maximum exposure conditions evaluated.

5.6.2.7 Future-Use Scenario: Lifetime Exposure of Residents to Contaminated Groundwater

As discussed in Section 5.4, the Republic Steel site could potentially be converted to a housing development in the future with groundwater on the site being used as a potable water supply. Potential health risks associated with exposure of residents to the chemicals of concern in groundwater through ingestion of groundwater was estimated by assuming that a 70-kg individual ingests two liters of groundwater a day for a 70-year lifetime. These assumptions are summarized in Table 5-30 and the equations used to estimate contaminant intakes are presented in Appendix B. Table 5-31 contains the risk estimates for this exposure scenario.

As Table 5-31 indicates, under average exposure, the hazard index is less than one. However, under maximum exposure conditions, the hazard index is greater than one; although only the CDI:RfD ratio for manganese exceeds one. Other chemicals that primarily contribute to the hazard index are cadmium, chromium, manganese and vanadium. All of these chemicals, except for manganese contribute to the same toxic endpoint (the liver).

Lead was not evaluated in Table 5-31 because as indicated in Appendix A EPA has not established a potency factor for lead and EPA considers it inappropriate to develop a reference dose since many of the health effects associated with lead intakes essentially occur without a threshold. However, the maximum concentration of lead in groundwater (19 ug/l) is below the MCL of 50 ug/l established for lead.

As indicated in Table 5-31, the lifetime upperbound excess cancer risk exceeds 10^{-6} for both the average and plausible maximum conditions evaluated. The risk is primarily due to ingestion of beryllium although bis(2-ethylhexyl)phthalate also contributes to the risk. Beryllium was detected in three of six wells and the maximum concentration was 2.1 ug/l. However, it is evaluated in this assessment because it was not detected in the background wells at a detection limit of 1.0 ug/l. It should be noted that beryllium has

TABLE 5-28
ASSUMPTIONS USED TO ESTIMATE EXPOSURE TO PARK PATRONS VIA CONTACT WITH SOIL -
FUTURE USE SCENARIO AT THE REPUBLIC STEEL SITE

Parameter	Average Case	Plausible Maximum Case
Frequency of Exposure	16 days/yr	40 days/yr
Period of Exposure	20 years	20 years
Incidental Ingestion ^a	50 mg/day	100 mg/day
Oral absorption factor ^b		
Metals	1	1
cPNAs	0.15	0.45
ncPNAs	0.50	1
Other organic chemicals	1	1
Daily Soil Contact Rate ^c	0.5 mg/cm ²	1.5 mg/cm ²
Area of Exposed Skin ^d	2,040 cm ²	2,040 cm ²
Dermal Absorption Factor ^e		
Metals	0	0
PNAs	0.003	0.03
Other organic chemicals	0.01	0.04
Average Body Weight	70 kg	70 kg
Exposure Point Concentrations ^f	Mean	Maximum

^a Based on the work of LaGoy 1987.

^b This factor represents the percentage of contaminants absorbed from ingested soil. Factor for metals and organic chemicals is default value assuming 100% absorption. Factors for cPNAs and ncPNAs based on

^c Based on the work of Schaum 1984.

^d EPA 1985.

^e This factor represents the percentage of contaminants absorbed through the skin.

^f These concentrations are shown in Table 5-13.

TABLE 5-29

CHRONIC DAILY INTAKES AND POTENTIAL RISKS TO PARK PATRONS VIA DIRECT CONTACT
WITH SOIL UNDER FUTURE-USE CONDITIONS AT THE REPUBLIC STEEL SITE (a)

POTENTIAL CARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (b) (mg/kg-day)		Potency Factor (mg/kg-day) ⁻¹	Lifetime Upper Bound Excess Cancer Risk	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Bis(2-ethylhexyl)phthalate (c)	NC	1.76E-08	1.4E-02	NC	2E-10
cPNA (c)	4.57E-10	3.12E-08	1.2E+01	5E-09	4E-07
Methylene chloride	1.62E-10	3.28E-09	7.5E-03	1E-12	2E-11
TOTAL	---	---	---	5E-09	4E-07
NONCARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (b) (mg/kg-day)		Reference Dose (RfD) (mg/kg-day)	CDI:RfD	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Acetone	1.39E-09	5.22E-08	1.0E-01	1E-08	5E-07
Bis(2-ethylhexyl)phthalate (c)	NC	6.16E-08	2.0E-02	NC	3E-06
2-Butanone (MEK)	NC	2.72E-08	5.0E-02	NC	5E-07
Butylbenzylphthalate (c)	NC	1.19E-07	2.0E-01	NC	6E-07
Cadmium	NC	7.05E-10	1.0E-03	NC	7E-07
Chromium	1.00E-06	2.79E-05	5.0E-03	2E-04	6E-03
Copper	2.66E-06	1.47E-05	3.7E-02	7E-05	4E-04
Manganese	2.64E-05	9.38E-04	2.2E-01	1E-04	4E-03
Mercury (inorganic)	NC	5.32E-08	3.0E-04	NC	2E-04
Methylene chloride	5.65E-10	1.15E-08	6.0E-02	9E-09	2E-07
ncPNA (c)	5.06E-09	3.27E-07	4.0E-03	1E-06	8E-05
Nickel	4.20E-10	1.14E-08	2.0E-02	2E-08	6E-07
HAZARD INDEX	---	---	---	<1 (4E-4)	<1 (1E-2)

(a) The assumptions made in developing the average and plausible maximum exposure cases are shown in Table 5-28. Exposure point concentrations are presented in Table 5-13.

(b) CDIs represent the total intake through dermal absorption and incidental ingestion.

(c) Concentrations of semi-volatile organic chemicals are from 2 RI samples and 2 confirmation samples collected following removal actions.

NC = Not calculated; chemical only detected in one sample or the mean value was less than the detection limit.

TABLE 5-30
ASSUMPTIONS USED TO ESTIMATE EXPOSURE TO RESIDENTS VIA INGESTION OF
DRINKING WATER -- FUTURE USE SCENARIO
AT THE REPUBLIC STEEL SITE

Parameter	Average Case	Plausible Maximum Case
Frequency of Exposure	365 days/yr	365 days/yr
Period of Exposure	70 years	70 years
Ingestion	2 liters/day	2 liters/day
Oral Absorption Factor Metals	1	1
Average Body Weight	70 kg	70 kg
Exposure Point Concentration	Mean	Maximum

TABLE 5-31

POTENTIAL EXPOSURES AND RISKS ASSOCIATED WITH INGESTION OF GROUNDWATER
UNDER FUTURE-USE CONDITIONS AT THE REPUBLIC STEEL SITE (a)

POTENTIAL CARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (mg/kg-day)		Potency Factor (mg/kg-day) ⁻¹	Lifetime Upper Bound Excess Cancer Risk	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Beryllium	2.86E-05	6.00E-05	4.3E+00	1E-04	3E-04
Bis(2-ethylhexyl)phthalate	1.80E-04	3.14E-04	1.4E-02	3E-06	4E-06
TOTAL	---	---	---	1E-04	3E-04
NONCARCINOGENS					
Chemical	Chronic Daily Intake (CDI) (mg/kg-day)		Reference Dose (RfD) (mg/kg-day)	CDI:RfD	
	Average Case	Plausible Maximum Case		Average Case	Plausible Maximum Case
Barium	1.83E-03	3.26E-03	5.0E-02	4E-02	7E-02
Benzoic acid	NC	1.20E-03	4.0E+00	NC	3E-04
Beryllium	2.86E-05	6.00E-05	5.0E-03	6E-03	1E-02
Bis(2-ethylhexyl)phthalate	1.80E-04	3.14E-04	2.0E-02	9E-03	2E-02
Cadmium	NC	1.83E-04	5.0E-04	NC	4E-01
Chromium	2.40E-04	5.71E-04	5.0E-03	5E-02	1E-01
Copper	3.14E-04	8.00E-04	3.7E-02	8E-03	2E-02
Di-n-butylphthalate	NC	1.11E-04	1.0E-01	NC	1E-03
Manganese	4.26E-02	3.31E-01	2.2E-01	2E-01	2E+00
Nickel	3.34E-03	3.74E-03	2.0E-02	2E-01	2E-01
Pentachlorophenol	NC	1.43E-04	3.0E-02	NC	5E-03
Phenol	NC	2.86E-04	6.0E-01	NC	5E-04
Silver	NC	1.17E-04	3.0E-03	NC	4E-02
Vanadium	8.29E-04	1.63E-03	7.0E-03	1E-01	2E-01
Zinc	1.46E-03	3.03E-03	2.1E-01	7E-03	1E-02
HAZARD INDEX	---	---	---	<1 (0.6)	>1 (3)

(a) The assumptions made in developing the average and plausible maximum exposure cases are shown in Table 5-30. Exposure point concentrations are presented in Table 5-17.

NC = Not calculated; chemical only detected in one sample or the mean value was less than the detection limit.

been assigned a cancer potency factor since completion of the EA performed during the RI report preparation. Available toxicity data at the time the RI was completed did not indicate potential carcinogenic health risks associated with beryllium. However, as a result of its recent classification as a carcinogen, it is concluded in this EA that ingestion of beryllium may pose potential health risks. Additionally, bis(2-ethylhexyl)phthalate was added as a chemical of concern in groundwater during this EA. Bis (2-ethylhexyl) phthalate has had its cancer potency factor increased between the preparation of the original EA and this revised EA. Consequently, bis(2-ethylhexyl) phthalate also may pose potential health risks based on this revised EA. It should also be mentioned that neither beryllium nor bis(2-ethylhexyl)phthalate are known to be associated with waste pickle liquor. Furthermore, residents in the vicinity of the site do not have private groundwater wells, but are on a public water supply system. Therefore, it is unlikely that groundwater would be developed as a source of drinking water in the future.

5.7 ECOLOGICAL RISK ASSESSMENT

In addition to potential exposure of the human population discussed in earlier sections of this report, aquatic life may also be exposed to contamination at the Republic Steel site. The quarry is the aquatic life habitat of potential concern since no evidence of chemicals being transported from the quarry to the Black River has been noted. Therefore only exposures of aquatic life to chemicals of concern in the quarry will be assessed. The quarry water is a potential habitat for both invertebrate and vertebrate species.

The chemicals that will be evaluated in this assessment of effects on aquatic life are the same chemicals evaluated for potential impacts to human health as these were not selected based on human health considerations; the chemicals of concern were selected on the basis of their presence at the site at concentrations above background. Thus, the chemicals of potential concern for the environmental assessment are listed in Table 5-32.

Fish can be exposed to the chemicals of concern at the Republic Steel site through direct contact with or ingestion of contaminated water in the quarry. Concentrations in the quarry water are available from the RI results and from using a model estimating steady state partitioning of the chemicals from sediment into the water column as described in the sediment/water partitioning model in Section 5-6. In addition to exposure to water, fish and other aquatic life may also be exposed to chemical contaminants at the Republic Steel site via contact with contaminated sediments and ingestion of contaminated food. However, toxicity data are not available to assess exposure via sediment and ingestion of contaminated food, and therefore this exposure assessment is limited to an assessment of exposure to contaminated surface water.

In order to determine potential impacts on aquatic life a comparison is made between surface water concentrations in the quarry and State and Federal ambient water quality criteria (AWQC). Table 5-32 presents maximum surface water concentrations and the acute ambient water quality criteria (AWQC), and average surface water concentrations and the chronic AWQC. With respect to potential impacts on aquatic life in the quarry, of the 18 chemicals with

TABLE 5-32
COMPARISON OF SURFACE WATER CONCENTRATIONS AT THE REPUBLIC STEEL SITE
WITH AWQC TOXICITY VALUES

Chemical	Concentration in Water (ug/L)		State Water Quality Criteria Aquatic Life (ug/L)		Federal Water Quality Criteria	
			30 Day			
	Average	Maximum	Average ^a	Maximum ^a	Chronic	Acute
Tetrachloroethene	0.0013	0.011	73	540	840	5,280
Ethylbenzene	0.00029	0.0025	62	1,400	--	32,000 ^f
2-Butanone	1.0	8.0	7.1	160	--	--
ncPNA	0.00014	0.00060	--	--	620 ^{e,f}	2,300 ^{e,f}
cPNA	0.000050	0.00058	--	--	--	--
Copper	18	96	12 ^b	18 ^b	12	18
Mercury	0.44	0.81	0.20	1.1	0.012	2.4
Pentachlorophenol	0.015	0.043	5.2 ^d	8.7 ^d	13	20
Acetone	3.4	42	78	550	--	--
Methylene Chloride	NA	0.28	430	9,700	--	--
bis(2-ethylhexyl) phthalate	0.0042	0.061	8.4	1,100	3 ^{c,f}	940 ^{c,f}
Diethylphthalate	518	7,780	120	2,600	3 ^{c,f}	940 ^{c,f}
Nickel	NA	86	170 ^b	1,600 ^b	160	1,400
Vanadium	4.4	60	--	--	--	--
Calcium	56,700	315,000	--	--	--	--
Tin	0.44	4.8	--	--	--	--
Barium	46	113	--	--	--	--
Manganese	940	25,700	--	--	--	--
Butylbenzylphthalate	0.014	0.405	--	--	3 ^{c,f}	940 ^{c,f}
Di-n-butylphthalate	0.0012	0.017	190	350	3 ^{c,f}	940 ^{c,f}
Di-n-octylphthalate	0.012	0.03	--	--	3 ^{c,f}	940 ^{c,f}
Toluene	0.009	0.11	1,700	2,400	--	17,500 ^b
Cadmium	NA	12	1.4 ^b	5.6 ^b	1.1 ^b	3.9 ^b
Iron	2,530	1,600,000	1,000	--	--	1,000

NA = The mean value was below detection.

^a Outside mixing zone for warmwater and seasonal salmonid habitats

^b Hardness dependent parameter (100 mg/l CaCO₃ used)

^c As phthalate esters. Insufficient data to develop criteria. Value presented at the lowest observed effect level.

^d pH of 7.0

^e For naphthalene

^f Insufficient data to develop criteria. Value presented is L.O.E.L. - Lowest Observed Effect Level. These are not promulgated standards, presented for information purposes only.

acute AWQC values, only the maximum concentrations of copper, diethylphthalate and cadmium exceed maximum Ohio criteria and acute Federal criteria. Additionally, the maximum concentration of iron exceeds the acute federal AWQC. Average concentrations of copper, mercury and diethylphthalate exceed the Federal chronic AWQC and the 30-day average concentrations for Ohio. The 30-day average concentration for iron in Ohio is exceeded by the average concentration of iron.

It should be noted that average and maximum concentrations of all chemicals except barium, vanadium, manganese, cadmium, iron and nickel were calculated using the sediment/water partitioning model. The model is conservative and chemical concentrations in the water are not expected to be as large as those predicted by the model.

EPA (Zarba 1988) is currently in the process of establishing sediment criteria for the protection of aquatic benthic organisms. Although EPA's Office of Water notes that these criteria are interim in nature, they have been recommended for use at Superfund sites. Of the chemicals found at Republic Steel, EPA has developed interim criteria values for the PNAs. With Zarba assuming 1% organic carbon in the sediment, the mean interim sediment quality criteria values range from 1.39 mg/kg for phenanthrene to 18.8 ug/kg for fluoranthene. The upper confidence levels range from 6.05 mg/kg for phenanthrene to 83.8 for fluoranthene. EPA considers sediments with concentrations higher than the upper confidence levels to be hazardous to benthic fauna. These levels are comparable to the measured concentrations in the quarry sediments; thus, it is likely that a viable benthic community could not be supported based on chemical evidence alone.

5.8 RISK ASSESSMENT UNCERTAINTIES

The procedures and inputs used to assess risks in this EA, as in all such assessments, are subject to a wide variety of uncertainties. In general, sources of uncertainty include: environmental chemistry sampling and analysis; environmental parameter measurement; fate and transport modeling; exposure parameter estimation; and toxicological data. Uncertainties are summarized on Table 5-33.

Uncertainty in environmental sampling arises in part from the potentially uneven distribution of chemicals in the media samples. Typically, this problem is encountered more frequently in soil than water. A problem specific to the Republic Steel Quarry is that no background surface water or sediment samples could be collected; samples from the Black River were used for comparison purposes only since the Black River does not flow into the quarry.

Chemicals that are not on EPA's Target Compound List (TCL) may contribute to risk, especially if they are present at a high concentration. Cutting oils are insoluble lubricants and coolants in cutting, threading, and similar metal working operations. Cutting oils are a fraction of crude oil distillate that is a complex mixture of several hundred organic compounds, these are mostly straight-run refined, medium-viscosity oils from paraffinic, mixed-base, and naphthenic crudes (Kirk-Othmer 1982). While a large number of these compounds

TABLE 5-33
UNCERTAINTIES IN THE RISK ASSESSMENT FOR THE REPUBLIC STEEL SITE

Assumption	Magnitude of Effect on Risk	Direction of Effect on Risk
<u>Environmental Sampling and Analysis</u>		
Sufficient samples may not have been taken to characterize the matrices being evaluated.	Moderate	May over- or under-estimate risk
Systematic or random errors in the chemical analyses may yield erroneous data.	Low	May over- or under-estimate risk
Chemical concentrations reported as "below method detection limit" are included as one-half the CLP required detection limit.	Moderate	May over- or under-estimate risk
The endangerment assessment is based on the chemicals of concern, rather than the complete data set.	Moderate	May underestimate risk
<u>Fate and Transport Modelling</u>		
The models used to estimate water concentrations assume simple steady-state partitioning.	Moderate	May over- or under-estimate risk
<u>Toxicological Data</u>		
Some of the cancer potencies used are upper 95 percent confidence limits derived from the linearized multi-stage model.	High	May overestimate risk
Risks are assumed to be additive. Risks may not be additive because of synergistic or antagonistic actions of other chemicals.	Moderate	May over- or under-estimate risk
Oral RfDs have been used to evaluate exposure through dermal contact.	Moderate	May over- or under-estimate risk

TABLE 5-33 (Continued)

Assumption	Magnitude of Effect on Risk	Direction of Effect on Risk
<u>Exposure Parameter Estimation</u>		
The standard assumptions regarding body weight, period exposed, life expectancy, population characteristics, and lifestyle may not be representative for any actual exposure situation.	Moderate	May overestimate risk
The amount of media intake is assumed to be constant and representative of the exposed population.	Moderate	May overestimate risk
Exposure to contaminants remains constant over exposure period.	Moderate	May over- or under-estimate risk
Concentration of contaminants remains constant over exposure period.	Moderate	May over- or under-estimate risk
Dermal absorption of inorganic chemicals from soil is negligible.	Low	May underestimate risk
For most contaminants all intake is assumed to come from the medium being evaluated. This does not take into account other contaminant sources such as diet, exposures occurring at locations other than the exposure point being evaluated, or other environmental media which may contribute to the intake of the chemical (i.e., relative source contribution is not accounted for).	Moderate	May underestimate risk

are straight-chained, low toxicity hydrocarbons, many are polynuclear aromatic hydrocarbons. When released to the environment, the components of cutting oils are subject to differential chemical fate and transport processes.

The concept of food-chain transport of PNAs poses many questions. Although there is evidence that aquatic organisms can rapidly assimilate PNAs (Eisler 1987), there is also evidence that these compounds are rapidly metabolized and eliminated (Eisler 1987). In one laboratory ecosystem study (Lu 1977) in mosquito fish, BaP was 93% metabolized within 33 days of exposure. The tendency of fish to metabolize BaP and related compounds may explain why BaP is often not detected or detected in only low amounts in environmental situations where predictions based on BCFs would indicate higher levels. It is not known if the metabolites, some of which are potentially carcinogenic, can be absorbed in biologically active forms from food. The strong and rapid tendency for these metabolites to form DNA adducts (Williams and Weisburger 1986) indicates that they are not persistent in a biological environment.

Another potential source of uncertainty in this risk assessment is from modeling of sediment concentrations into fish. As discussed, a conservative mixing model was used to calculate surface water exposure point concentrations for chemicals of concern in sediment. Thus risks via ingestion of fish from the quarry are likely to be an overestimate.

With respect to the exposure scenarios evaluated in this risk assessment, there are several uncertainties in determining the exposure parameters that go into the scenario that will ultimately be combined with toxicological information to assess risk. For example, there are a number of uncertainties regarding estimates of how often, if at all, an individual would come into contact with the chemicals of concern and the period of time over which such exposures would occur. Risks for certain individuals within an exposed population will be higher or lower than the risks shown depending on actual intakes, body weights, etc. Table 5-33 summarizes the uncertainties of the risk assessment.

Toxicological data extrapolation is probably the largest source of error in risk assessments. As EPA noted in its Guidelines for Carcinogenic Risk Assessment (EPA 1986d):

There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns, and other cultural factors.

A particular problem is also presented by the necessity to perform risk assessments for PNAs. PNAs occur in the environment as complex mixtures of many components with widely varying toxic potencies. Only a few components of these mixtures have been characterized adequately, and only limited information is available on potential synergistic or antagonistic effects of the PNAs mixture. Most evidence on PNAs carcinogenic potency indicates that BaP is more potent than most of the other carcinogenic PNAs or even a mixture of carcinogenic PNAs (Schmahl et al. 1977, Pfeiffer 1977); therefore, the

technique used in this assessment will probably overestimate risk. A further uncertainty presented by the PNAs is the absence of research data and health effects criteria for the noncarcinogenic PNAs.

5.9 CONCLUSIONS

In this endangerment assessment, the potential risks to human health attributed to chemicals present at the Republic Steel Quarry site were evaluated under a number of exposure scenarios. Potential pathways of exposure to chemicals originating at the site under both current-use and hypothetical future-use conditions were examined. Table 5-34 presents a summary of the risks associated with the various scenarios evaluated. Additionally, combined risks are presented for those exposure pathways that could potentially apply to the same receptors.

Under current-use conditions, none of the exposure scenarios result in a greater than 10^{-6} risk. Additionally, the hazard index is less than one for all exposure scenarios evaluated with the exception of the plausible maximum exposure scenario for consumption of fish. The hazard index for the plausible maximum exposure scenario for consumption of fish is equal to one. However, the three chemicals that primarily contribute to the hazard index do not have the same endpoint of toxicity. Additionally, the chemical comprising the largest percentage of the hazard index for consumption of fish is cadmium. It should be noted that cadmium was added as a chemical of concern in this EA, and was detected in only one of twenty samples. Combined risks to trespassers, assuming the same person would be exposed to soil through direct contact and incidental ingestion, quarry water through swimming, and fish through ingestion were estimated. As indicated in Table 5-34 the combined upperbound excess lifetime cancer risks are 1×10^{-8} and 7×10^{-7} under average and maximum exposure conditions, respectively. The combined hazard index is less than one under the average scenario and equal to one under the maximum scenario. Additional data on cadmium and copper concentrations in fish tissue would aid in evaluating current-use fish consumption exposure scenarios. It is anticipated that cadmium and copper concentrations would be lower in the fish tissue than predicted by the conservative modeling (as was the case with mercury and manganese concentrations in the fish tissue). As a result, the hazard index for fish consumption and combined risk cases may be less than 1.

Under future-use conditions the exposure scenarios evaluated that resulted in a greater than 10^{-6} upperbound excess lifetime cancer risk are maximum exposure to future residents through direct contact and incidental ingestion of soil, and average and maximum exposure via ingestion of groundwater. Consequently the combined potential residential risk is 1×10^{-4} to 3×10^{-4} under average and maximum exposure scenarios. This risk is primarily due to the beryllium in groundwater, although bis(2-ethylhexyl)phthalate also contributes to the risk. Although the maximum concentration of beryllium is low (2.1 ug/l) it was included in this assessment because beryllium was not detected in samples from the background wells at a detection limit of 1.0 ug/l. It should be noted that beryllium has been assigned a cancer potency factor since completion of the EA performed during the RI report preparation. As a result

TABLE 5-34
SUMMARY OF POTENTIAL RISKS ASSOCIATED WITH THE REPUBLIC STEEL QUARRY

Exposure Scenario	Total Cancer Risks		Noncarcinogenic Hazard Index	
	Average	Maximum	Average	Maximum
<u>Current-Use</u> (Trespassers)				
Direct Contact with Soil	2×10^{-9}	1×10^{-7}	<1	<1
Swimming in the Quarry	8×10^{-12}	3×10^{-10}	<1	<1
Consumption of Fish	8×10^{-9}	6×10^{-7}	<1	=1
Combined Risk to Trespassers	1×10^{-8}	7×10^{-7}	<1	=1
<u>Future-Use</u>				
Park Patron - Direct Contact with Soil	5×10^{-9}	4×10^{-7}	<1	<1
Residential Use - Direct Contact with Soil	5×10^{-8}	5×10^{-6}	<1	<1
Residential Use - Ingestion of Groundwater	1×10^{-4}	3×10^{-4}	<1	>1
Combined Residential Risk	1×10^{-4}	3×10^{-4}	<1	>1

of its recent classification as a carcinogen, it is concluded that ingestion of beryllium may pose potential health risks. However, toxicity data available at the time the RI was completed did not indicate there were potential health risks associated with ingestion of beryllium. Additionally, bis(2-ethylhexyl) phthalate was added as a chemical of concern in groundwater during this EA. Bis(2-ethylhexyl)phthalate has had its cancer potency factor increased between the preparation of this original EA and this revised EA. Consequently, bis(2-ethylhexyl) phthalate also may pose potential health risks based on this revised EA. It should also be mentioned that neither beryllium nor bis(2-ethylhexyl)phthalate are known to be associated with waste pickle liquor. In evaluating the noncarcinogenic risk associated with future-use of the site, the hazard index is greater than one under the maximum assumptions evaluating ingestion of groundwater. This is primarily due to manganese, because the chronic daily intake for manganese exceeds the reference dose. Other chemicals that primarily contribute to the hazard index are cadmium, chromium, manganese and vanadium. All of these chemicals except for manganese contribute to the same toxic endpoint (the liver). It should be pointed out that residents in the vicinity of the site do not have private groundwater wells and it is therefore unlikely that groundwater would be developed as a source of drinking water in the future. Drinking water would more likely be provided by the City of Elyria public water supply.

Chemicals with acute AWQC values, maximum concentrations of copper, diethylphthalate and cadmium exceed maximum Ohio criteria and acute Federal criteria. Additionally, the maximum concentration of iron exceeds the acute Federal AWQC. Average concentrations of copper, mercury and diethylphthalate exceed the chronic AWQC and 30-day average concentrations for Ohio. The 30-day average concentration for iron in Ohio is exceeded by the average concentration of iron.

It should be noted for the surface water concentrations that all chemicals except barium, vanadium, manganese, cadmium, iron and nickel were calculated using the sediment/water partitioning model. The model is conservative and chemical concentrations in the water are not expected to be as large as those predicted by the model.

As stated earlier, the primary purpose of this revised EA was to incorporate recent sampling results. At the same time, current toxicity values and ARARs were also applied. As a result of using current toxicity values, some chemicals presented a potential health risk in this EA that previously did not. This endangerment assessment has not been revised to conform to regulations and guidance which have been promulgated since the original endangerment assessment was completed. The reasons for continuing with the previous guidance procedures for the endangerment assessment are because: 1) the revised EA methods and procedures will be consistent with the original EA which served to direct further investigation activities at this site; 2) budgetary constraints prohibited the performance of this EA using new guidance (because essentially an entirely new EA would have to be performed); and, 3) previous guidance generally utilizes more conservative assumptions for evaluating risks posed by the site, resulting in a more conservative assessment for protecting human health and the environment. In particular, the methodology and results in this EA do not reflect the National Contingency Plan promulgated in March 1990, EPA's Risk Assessment Guidance for Superfund, published in December 1989, and OSWER Directive 9850.4 on Interim

Final Guidance for Soil Ingestion Rates. Additionally, EPA currently recommends using an integrated uptake/biokinetic model for assessment of exposure to lead at Superfund sites. Although a formal sensitivity analysis has not been prepared, it is likely that the risks reported in this document are higher than if they had been calculated using current guidance. This factor should be taken into account by risk managers in the process of decision making at the Republic Steel Quarry site.

6.0 CONCLUSIONS

Remedial Action and confirmatory sampling tasks specified in the Record of Decision (ROD) for the Republic Steel Quarry Site have been completed. Approximately 130 cubic yards of contaminated soil were removed and disposed in a regulated hazardous waste landfill. Groundwater was resampled and fish tissue samples were collected to better assess risks at the site. Risks posed under current- and future-use scenarios were reassessed in this report to establish revised risks after performance of the above tasks. No unacceptable health risks were identified under current-use exposure scenarios. The new fish tissue data showed that conservative uptake modeling performed in the Remedial Investigation (RI) Report had overestimated concentrations of mercury and manganese in fish tissue by an order of magnitude, which in turn overestimated the risks. By removing contaminated soils, risks posed by direct contact with soil were also decreased. Risks associated with direct contact with soils were also reduced to acceptable levels under the future-use scenarios because the contaminated soils were removed. Unacceptable risks were, however, identified under future residential use - ingestion of groundwater scenario. Another round of groundwater sampling demonstrated that methylene chloride was not present in the groundwater. Methylene chloride was a contaminant of concern in groundwater in the RI and drove a substantial portion of the groundwater ingestion risk. New toxicity information on bis(2-ethylhexyl)phthalate and beryllium, however, generated new risks which were not established during the RI.

This report documents that the objectives of the September 29, 1988 ROD have been accomplished; i.e., the soil removal and additional sampling show that the site poses acceptable risks except under the future-use ingestion of groundwater scenario. The next step in the process is for U.S. EPA and OEPA to determine if the groundwater problems at the Republic Steel Quarry warrant any further remedial action. The National Contingency Plan (NCP) gives the Agencies some latitude in making these decisions. Considerations such as the likelihood that this groundwater will be used given the existence a municipal water supply and the extent of the beryllium contamination will be taken into account.

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APPENDIX A
ADDITIONAL TOXICITY PROFILES

BENZOIC ACID

Benzoic acid is absorbed following both oral and dermal exposure (Opdyke 1979). Large oral doses of benzoic acid produce gastric pain, nausea, and vomiting in humans (Gosselin et al. 1984). The lowest reported oral lethal dose in humans is 500 mg/kg body weight (Opdyke 1979). In experimental studies with cats, oral benzoic acid doses of 0.13 to 0.30 g/kg body weight given daily for 1 to 30 days induced central nervous system disturbances; longer-term feeding of benzoic acid at daily doses of 0.2 g/kg body weight induced liver damage (Opdyke 1979). One report indicated that benzoic acid vapors are highly toxic by inhalation (Sax 1984); however, this report provided no data relating to exposure conditions and doses. Although benzoic acid itself has not been reported to be teratogenic, experimental animals treated with benzoic acid have demonstrated increased sensitivity to the teratogenic effects of salicylic acid and aspirin (Opdyke 1979). Benzoic acid has tested negative for mutagenic activity in a number of assay systems. No reports were available regarding the carcinogenic potential of this compound.

Benzoic acid has been approved for food use by the Food and Drug Administration and is considered a "generally recognized as safe" (GRAS) food additive (Opdyke 1979). The Joint FAO/WHO Expert Committee on Food Additives (1974) has previously estimated an acceptable daily intake (ADI) for benzoic acid by ingestion of up to 5 mg/kg. The EPA has determined an oral RfD of 4 mg/kg/day for both chronic (EPA 1990) and subchronic (EPA 1989) exposure to benzoic acid based on a no-observed-adverse-effect level (NOAEL) of 312 mg/day in humans. An uncertainty factor of 1 was used in calculating the oral RfD. No inhalation health criteria have been developed by EPA.

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BERYLLIUM

Beryllium is not readily absorbed by any route of exposure. Occupational exposure to beryllium results in bone, liver and kidney depositions (EPA 1986). In humans, acute respiratory effects due to beryllium exposure include rhinitis, pharyngitis, tracheobronchitis, and acute pneumonitis. Dermal exposure to soluble beryllium compounds can cause contact dermatitis, ulceration and granulomas (Hammond and Beliles 1980). Ocular effects include conjunctivitis and corneal ulceration from splash burns. The most common clinical symptom caused by chronic beryllium exposure is granulomatous lung inflammation (IARC 1980, EPA 1986). Chronic skin lesions sometimes appear after a long latent period in conjunction with the pulmonary effects. Systemic effects from beryllium exposure may include right heart enlargement with accompanying cardiac failure, liver and spleen enlargement, cyanosis, digital clubbing, and kidney stone development (EPA 1986, Schroeder and Mitchner 1975). Beryllium has been shown to be carcinogenic in experimental animals resulting primarily in lung and/or bone tumors when given by injection, intratracheal administration, or inhalation (EPA 1986). Chronic oral administration to rats resulted in an increased occurrence of gross tumors of all sites combined (Schroeder and Mitchner 1975). Several epidemiological studies have suggested that occupational exposure to beryllium may result in an increased lung cancer risk although the data are inconclusive (EPA 1986, Wagoner et al. 1980).

Beryllium has been classified by EPA in Group B2--Probable Human Carcinogen based on increased incidences of lung cancer and osteosarcomas in animals (EPA 1990). EPA (1990) has calculated an inhalation cancer potency factor of $8.4 \text{ (mg/kg/day)}^{-1}$ based on the relative risk for lung cancer, estimated from an epidemiological study by Wagoner et al. (1980). EPA (1990) established an oral cancer potency factor of $4.3 \text{ (mg/kg/day)}^{-1}$ based on the induction of tumors (type and site unspecified) in rats chronically administered beryllium sulfate in their drinking water (Schroeder and Mitchner 1975). EPA (1990) has also developed an oral reference dose (RfD) for beryllium of $5.0 \times 10^{-3} \text{ mg/kg/day}$ based on a study by Schroeder and Mitchner (1975) in which rats

exposed to 0.54 mg/kg/day beryllium sulfate (the highest dose tested) in drinking water for a lifetime did not exhibit adverse effects; an uncertainty factor of 100 was used to develop the RfD.

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BUTYL BENZYL PHTHALATE

Butyl benzyl phthalate is absorbed following oral exposure. Butyl benzyl phthalate is not especially toxic. Acute oral doses of 50,000 or 100,000 mg/kg administered to male rats resulted in testicular degeneration. Thymic atrophy was reported in both male and female rats given 100,000 mg/kg for 14 days (NTP 1982). Depressed body weight gain, testicular degeneration, and liver and kidney effects have been observed in animals subchronically administered benzyl butyl phthalate in the diet (NTP 1982, NTP 1985). Butyl benzyl phthalate has been tested for carcinogenicity in chronic feeding studies using mice and female rats, and via intraperitoneal injection in male mice (NTP 1982). In female rats, an increased incidence of myelomonocytic leukemia was observed in the high exposure group. No increased tumor incidence was noted for mice (NTP 1982).

EPA has classified butyl benzyl phthalate in Group C--Possible Human Carcinogen. EPA (1989) derived an oral RfD of 2×10^{-1} mg/kg/day for butyl benzyl phthalate based on a subchronic study in rats in which effects on body weight gain, testes, liver, and kidney were observed (NTP 1985). An uncertainty factor of 1,000 was used to derive the oral RfD. No inhalation criteria have been developed for butyl benzyl phthalate.

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CADMIUM

Gastrointestinal absorption of cadmium in humans ranges from 5-6% (EPA 1985a). Pulmonary absorption of cadmium in humans is reported to range from 10% to 50% (CDHS 1986). Cadmium bioaccumulates in humans, particularly in the kidney and liver (EPA 1985a,b). Chronic oral or inhalation exposure of humans to cadmium has been associated with renal dysfunction, itai-itai disease (bone damage), hypertension, anemia, endocrine alterations, and immunosuppression. Renal toxicity occurs in humans at a renal cortex concentration of cadmium of 200 $\mu\text{g/g}$ (EPA 1985b). Epidemiological studies have demonstrated a strong association between inhalation exposure to cadmium and cancers of the lung, kidney, and prostate (EPA 1985b, Thun et al. 1985). In experimental animals, cadmium induces injection-site sarcomas and testicular tumors. When administered by inhalation, cadmium chloride is a potent pulmonary carcinogen in rats. Cadmium is a well-documented animal teratogen (EPA 1985b).

EPA (1989, 1990) classified cadmium as a Group B1 agent (Probable Human Carcinogen) by inhalation. This classification applies to agents for which there is limited evidence of carcinogenicity in humans from epidemiologic studies. EPA (1989, 1990) derived an inhalation cancer potency factor of $6.1 (\text{mg/kg/day})^{-1}$ for cadmium based on epidemiologic studies in which respiratory tract tumors were observed (Thun et al. 1985, EPA 1985b). Using renal toxicity as an endpoint, and a safety factor of 10, EPA (1989, 1990) has derived two separate oral reference doses (RfD). The RfD associated with oral exposure to drinking water is $5 \times 10^{-4} \text{ mg/kg/day}$, and is based upon the lowest-observed-adverse-effect level (LOAEL) of 0.005 mg/kg in humans (EPA 1985a, Friberg et al. 1974). The RfD associated with exposure to cadmium in food or other nonaqueous oral exposures is $1 \times 10^{-3} \text{ mg/kg/day}$.

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LEAD

Absorption of lead from the gastrointestinal tract of adult humans is estimated at 8%-45%. In children, absorption from non-paint sources ranges from 30% to 50% (Hammond and Beliles 1980, EPA 1986). There are other interpretations of the data (Duggan 1983) that suggest this may be as high as 70%. For adult humans, the deposition rate of particulate airborne lead is 30%-50%, and essentially all of the lead deposited is absorbed. Lead is stored in the body in the kidney, liver, and bone (EPA 1984). The major adverse effects in humans caused by lead include alterations in the hematopoietic and nervous systems. The toxic effects are generally related to the concentration of this metal in blood. Blood concentration levels of over 80 $\mu\text{g}/\text{dl}$ in children and over 100 $\mu\text{g}/\text{dl}$ in sensitive adults can cause severe, irreversible brain damage, encephalopathy, and possible death. The Centers for Disease Control (CDC 1985) have used the value of 25 $\mu\text{g}/\text{dl}$ as an acceptable level of blood lead. Recent information (EPA 1988), however, indicates that physiological and/or biochemical effects can occur even at lower levels. These include enzyme inhibition (16 $\mu\text{g}/\text{dl}$), elevated erythrocyte protoporphyrin (15 $\mu\text{g}/\text{dl}$), interference with Vitamin D metabolism, cognitive dysfunction in infants (10 to 15 $\mu\text{g}/\text{dl}$), electrophysiological dysfunction (6 $\mu\text{g}/\text{dl}$), and reduced childhood growth (4 $\mu\text{g}/\text{dl}$). Decreased fertility, fetotoxic effects, and skeletal malformations have been observed in experimental animals exposed to lead (EPA 1984). Chronic oral ingestion of certain lead salts (lead acetate, lead phosphate, lead subacetate) has been associated in experimental animals with increased renal tumors. Doses of lead that induced kidney tumors were high and were beyond the lethal dose in humans (EPA 1985).

EPA classified certain lead salts in Group B2—Probable Human Carcinogen, although no cancer potency factor has been established (EPA 1989a). This category applies to those agents for which there is sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans. EPA (1988) has recently proposed a maximum contaminant level goal (MCLG) of zero for lead. EPA (1989a) has considered it inappropriate to

develop a reference dose (RfD) for inorganic lead and lead compounds, since many of the health effects associated with lead intake occur essentially without a threshold. The new proposed MCLG is based on subtle effects of lead at low blood levels, the overall Agency goal of reducing lead exposures, and the probable carcinogenicity of lead at very high doses. Underlying this proposal was the assumption that blood lead levels in the range of 10-15 $\mu\text{g}/\text{dl}$ are associated with serious effects. Additionally EPA noted that existing body burdens of lead were already in the range where adverse effects could result.

An alternative approach is also undergoing review by EPA to evaluate potential subchronic lead exposures to young children. This approach is based on a linear pharmacokinetic model used by EPA's Office of Air Quality Planning and Standards (OAQPS) for lead air quality standard setting (EPA 1989b). The model, based on work by Harley and Kneip (1985), takes into account the uptake, retention and excretion of lead. It is referred to as the "Integrated Uptake/Biokinetic Model", and it estimates blood lead levels.

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PHENOL

Phenol is readily absorbed through the gut, by inhalation, and percutaneously (EPA 1980). Signs of acute phenol toxicity in humans and experimental animals are central nervous system depression, collapse, coma, cardiac arrest, and death. Acutely toxic doses can also cause extensive necrosis at the site of exposure (eyes, skin, oropharynx) (EPA 1980). In experimental animals subchronic oral and inhalation studies suggest that kidney, pulmonary, myocardial, and liver damage are associated with exposure, although many of these studies were poorly designed (EPA 1980, 1984). Oral administration of phenol to pregnant rats during gestational days 6 to 15 resulted in a significant reduction in fetal body weight (NTP 1983). Phenol exhibited tumor-promoting activity in the mouse skin painting system following initiation with 9,10-dimethyl-1,2-benzanthracene (DMBA) or benzo[a]pyrene (B[a]P), and it exhibited cutaneous carcinogenic activity in a sensitive mouse strain when applied at concentrations that produced repeated skin damage (EPA 1980).

EPA has established an oral chronic (EPA 1990) and subchronic (EPA 1989) reference dose (RfD) of 0.6 mg/kg/day for phenol based on reduced fetal body weight in rats (NTP 1983). A no-observed-adverse-effect level (NOAEL) of 60 mg/kg/day and a safety factor of 100 were used to derive both chronic and subchronic RfDs. EPA has not yet established an inhalation RfD (EPA 1990).

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POLYCYCLIC AROMATIC HYDROCARBONS (Noncarcinogenic)

Polycyclic aromatic hydrocarbons (PAHs) occur in the environment as complex mixtures of which only a few components have been adequately characterized. Only limited information is available on the relative potencies of the "noncarcinogenic" PAHs. However, many have been shown to have some weak carcinogenic activity, or to act as promoters or cocarcinogens.

PAH absorption following oral and inhalation exposure is inferred from the demonstrated toxicity of PAHs following these routes of administration (EPA 1984). PAHs are also absorbed following dermal exposure (Kao et al. 1985). Acute effects from direct contact with PAHs and related materials are limited primarily to phototoxicity; the primary effect is dermatitis (NIOSH 1977). PAHs have also been shown to cause cytotoxicity in rapidly proliferating cells throughout the body; the hematopoietic system, lymphoid system, and testes are frequent targets (Santodonato et al. 1981). Some of the noncarcinogenic PAHs have been shown to cause systemic toxicity but these effects are generally seen at high doses (Santodonato et al. 1981). Slight morphological changes in the liver and kidney of rats have been reported following oral exposure to acenaphthene for 40 days (EPA 1984). Subchronic oral administration of naphthalene to rabbits and rats has resulted in cataract formation (Schmahl 1955).

EPA (1989) developed an oral reference dose of 4×10^{-3} mg/kg/day for naphthalene based on the development of ocular and systemic lesions in rats (Schmahl 1955, EPA 1986). An uncertainty factor of 10,000 was applied to the animal data in the development of the reference dose.

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VANADIUM

Pentavalent vanadium compounds are generally considered to be more toxic than other valence states. Many incidents of short-term and long-term occupational exposures to vanadium, mainly vanadium pentoxide dust, have been reported. Inhalation causes respiratory tract irritation, coughing, wheezing, labored breathing, bronchitis, chest pains, eye and skin irritation and discoloration of the tongue (NIOSH 1977, NAS 1974). Effects seen in experimental animals following chronic inhalation exposure include fatty degeneration of the liver and kidneys, hemorrhage, and bone marrow changes (Browning 1969).

EPA (1989) has derived an oral reference dose (RfD) of 7×10^{-3} mg/kg/day based on a chronic study in which rats received vanadium in their drinking water (Schroeder et al. 1970). A no-observed-adverse-effect level (NOAEL) of 0.77 mg/kg/day and an uncertainty factor of 100 were used to develop the RfD. EPA (1990) has established an oral RfD for vanadium pentoxide of 9×10^{-3} mg/kg/day. This value is based on a chronic rat study in which a NOAEL of 0.89 mg vanadium pentoxide/kg/day was noted. The only reported effect was a decrease in the amount of cystine in the hair (Stokinger et al. 1953). An uncertainty factor of 100 was used to calculate the vanadium pentoxide RfD. EPA has not developed inhalation criteria for vanadium.

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APPENDIX B

CALCULATIONS USED TO PREDICT RISK

SUMMARY OF CALCULATIONS USED TO ESTIMATE CONTAMINANT INTAKES

This appendix provides an explanation of the approach used to calculate human exposures to contaminants present at the site.

INCIDENTAL INGESTION OF CONTAMINATED SOIL

The chronic daily intake associated with incidental ingestion of contaminated soil is calculated using the following equation:

$$CDI = \frac{(C_s) (F) (P) (DER) (X) (ABS)}{(BW) (Y) (AT)}$$

where

- CDI = chronic daily intake in mg/kg/day;
- C_s = chemical concentration in soil in ug/kg;
- F = frequency of exposure in days per year;
- P = period of exposure in years;
- DER = daily exposure rate for incidental soil ingestion in mg/kg;
- X = conversion factor of 1 kg/1x10⁹ ug;
- ABS = oral absorption factor;
- BW = body weight in kg;
- Y = conversion factor of 365 days/1 year; and
- AT = averaging time - a lifetime of 70 years for potential carcinogens and the period of exposure for noncarcinogens.

DERMAL CONTACT WITH CONTAMINATED SOIL

The chronic daily intake associated with dermal contact with contaminated soil is calculated using the following equation:

$$CDI = \frac{(C_s) (F) (P) (CR) (A) (X) (ABS)}{(BW) (Y) (AT)}$$

where

- CDI = chronic daily intake in mg/kg/day;
- C_s = chemical concentration in soil in ug/kg;
- F = frequency of exposure in days per year;
- P = period of exposure in years;
- CR = daily soil contact rate in mg/cm²;
- A = skin surface area exposed in cm²;
- X = conversion factor of 1 kg/1x10⁹ ug;
- ABS = dermal absorption factor;
- BW = body weight in kg;
- Y = conversion factor of 365 days/1 year; and
- AT = averaging time - a lifetime of 70 years for potential carcinogens and the period of exposure for noncarcinogens.

INGESTION OF CONTAMINATED GROUNDWATER

Chronic daily intake of chemical contamination through ingestion is estimated by the equation:

$$CDI = \frac{(C_w) (F) (P) (IR) (ABS) (X)}{(BW) (Y) (AT)}$$

where

CDI	=	chronic daily intake in mg/kg/day;
C _w	=	chemical concentration in water in ug/L;
F	=	frequency of exposure in days per year;
P	=	period of exposure in years;
IR	=	ingestion rate in L/day;
ABS	=	ingestion absorption factor;
X	=	conversion factor of 1 kg/1,000 ug;
BW	=	body weight in kg;
Y	=	conversion factor of 365 days/1 year; and
AT	=	averaging time - a lifetime of 70 years for potential carcinogens and the period of exposure for noncarcinogens.

INGESTION OF CONTAMINATED FISH

Chronic daily intakes of chemicals of potential concern via ingestion of contaminated fish are estimated as follows:

$$CDI = \frac{(C_F) (FI) (E) (P) (W)}{(BW) (Y) (AT)}$$

where

- CDI = chronic daily intake in mg/kg/day;
- C_F = chemical concentration in fish in mg/kg;
- FI = amount of fish ingested per meal in g/meal;
- E = number of fish meals per year from the on-site quarry;
- P = period of exposure in years;
- W = conversion factor of 1 kg/1,000 g;
- BW = body weight in kg;
- Y = conversion factor of 365 days/1 year; and
- AT = averaging time - a lifetime of 70 years for potential carcinogens and the period of exposure for noncarcinogens.

INGESTION OF CONTAMINATED SURFACE WATER WHILE SWIMMING

The chronic daily intake associated with ingestion of surface water while swimming is calculated using the following equation:

$$CDI = \frac{(C_w) (F) (P) (IR) (X) (Y)}{(BW) (Z) (AT)}$$

where

CDI	=	chronic daily intake in mg/kg/day;
C _w	=	chemical concentration in water in ug/L;
F	=	frequency of swimming in events per year;
P	=	period of exposure in years;
IR	=	ingestion rate in ml per event;
X	=	conversion factor of 1 L/1,000 ml;
Y	=	conversion factor of 1 mg/1,000 ug;
BW	=	body weight in kg;
Z	=	conversion factor 365 days/1 year; and
AT	=	averaging time - a lifetime of 70 years for potential carcinogens and the period of exposure for noncarcinogens.

DERMAL CONTACT WITH CONTAMINATED SURFACE WATER WHILE SWIMMING

Chronic daily intake of chemical contamination through dermal contact with surface water is estimated by the equation:

$$CDI = \frac{(C_w) (F) (D) (P) (SA) (PC) (X) (Y)}{(BW) (Z) (AT)}$$

where

- CDI = chronic daily intake in mg/kg/day;
- C_w = chemical concentration in water in ug/L;
- F = frequency of swimming in events per year;
- D = duration of exposure event in hours;
- P = period of exposure in years;
- SA = skin surface area in cm^2 ;
- PC = permeability constant in cm/hour;
- X = conversion factor of 1 L/1,000 cm^3 ;
- Y = conversion factor of 1 mg/1,000 ug;
- BW = body weight in kg;
- Z = conversion factor of 365 days/1 year; and
- AT = averaging time - a lifetime of 70 years for potential carcinogens and the period of exposure for noncarcinogens.